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Mining Institute of Scotland.—Ordinary meeting at Edinburgh.

OCTOBER 13.

Institute of Transport.—Meeting at Birmingham. Address by Sir Herbert Austin, K.B.E., M.P.

Institute of Metals (Scottish Local Section).—Chairman's address, with some notes on "Brass Foundry Casting," Paper by John Stirling.

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Institute of Automobile Engineers.—General meeting in London.

Sheffield Metallurgical Association.—Discussion of a selection of work by Professor K. Honda, of Japan.

Institute of Marine Engineers.—Meeting in London. Discussion on "Indicator Diagrams and Lessons therefrom."

Institute of British Foundrymen (Lancashire Branch, Burnley Section).—Ordinary meeting at Burnley. "Some Foundry Problems," Paper by J. Hogg.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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The Case of the Small Foundry.

Mr. H. Gratton's letter, which is printed elsewhere in this issue, though specifically dealing with the Irish Free State, really opens up a much larger question. The point brought out by our correspondent is that small country foundries do not require research as is generally understood, but some centre where they can get some simple technical advice on a current happening.

Though Mr. Gratton does not say it, he infers that the reports issued by the National Physical Laboratory or the British Cast Iron Research Association are of a highbrow character, incomprehensible to the average foundryman. Now, so far as the latter is concerned, remarks have been made in foundry circles that the Association has been wasting its time on the pettifogging little difficulties associated with foundry practice. Perhaps there was a grain of truth in this at one period of its career, but the Association is now so organised that the answering of such queries occupies a minimum of the director's time, because of the accumulated experience now available, together with the assistance of a "special library." Thus, if a sketch arrives from a quite small foundry showing a common defect in a well-known type of casting, it will be dealt with by turning up a card index concerning that particular type of casting. The card will refer to a dossier containing either a bibliography of the subject, lengthy abstracts or a full file of everything that has been published. An assistant can then easily prepare a report of how the defect is thought to have arisen, and measures which have proved satisfactory in the past. This report is usually commented upon by the director, giving an expression of opinion gained from actual experience or maybe reliable hearsay, taking into into consideration the facilities existing at the inquirer's foundry for the interpretation of chemical analyses or the preparation of a small amount of plant. The advantages of this system are:—(1) That it can still operate if the director is away from his office; (2) that the inquirer receives not merely a personal expression as to cause and cure, but the "boiled-down" opinion of everybody who has ever publicly recorded his views on the case in question; (3) that there is a valuable record gathered together for the use of posterity; (4) that the more it is used and the longer the system operates the more valuable it becomes; and (5) it is quicker than relying solely on the personal expression of opinion from one man who may be otherwise more seriously occupied.

Thus it is fairly clear that Mr. Gratton can confidently advise the foundries in the Irish Free State to become members of the British Cast Iron Research Association. They and the British rural foundries have perhaps the most to gain from joining.

Again, we appeal to this class of foundry owner to join the Institute of British Foundrymen, because by doing so they will meet with the leaders of thought in the industry and will learn its potentialities, possible economies to be effected, and will take part in visits to large foundries exhibiting the latest practice.

Pearlitic Cast Iron.

Mr. J. G. Pearce, the director of the British Cast Iron Research Association, has reviewed this subject in a confidential Bureau Report, No. A.S.3, for the benefit of the members.

Magnesium.*

The production of magnesium is now approaching the point where large quantities can be obtained at a reasonable price. New metallurgical developments have made possible the manufacture on a large scale of a metal of high purity, so that in its present status magnesium occupies a position similar to that once held by aluminium, and it has to a considerable degree the same potentialities.

Some years ago aluminium "arrived." We had known something about it, and we had made use of it industrially to a slight extent for many years, when it suddenly began to develop rapidly into a commercially available material of construction. New methods of reducing it from its ore made possible large-scale production of a more dependable metal at a much lower price than had been possible before. Magnesium, in a similar way, is developing rapidly now. Production methods have been evolved that are making possible a lower price and the avoidance of injurious impurities that for years have given this metal a bad name as a material of construction. Its uses are developing rapidly. Industries are testing it for various purposes and it is being studied as never before, for research with a possibility of immediate return is easier to finance than research for which the returns seem distant. Consequently our knowledge of the metal increases by leaps and bounds. Magnesium is worthy of attention at the present time, because it is "moving." It is a new arrival among the commercial metals.

Magnesium has not yet reached the point where its applications, especially as a material of construction, in the chemical engineering industries can be catalogued, but its properties and those of its alloys are becoming accurately known. It is possible to describe them and the uses that these metals are finding in other fields. Its application to the chemical engineer's field is left for him to discover.

As in the case of most pure metals, the proportional limit is low. The stress-strain diagram departs very gradually from a straight line and it is difficult to determine accurately the beginning of curvature. Since the slight deformation caused by a load increases the proportional limit, higher unit stresses may be applied than would be indicated by the proportional limits given in the table. The specific heat, thermal co-efficient of expansion, melting point and several other physical properties of magnesium are of the order of magnitude of those of aluminium.

The chemical properties of magnesium are more widely known than the physical properties of the metal and they have been used to a greater extent. Probably the one best-known fact regarding magnesium is that it will burn in air. We should expect from this that the metal would corrode readily and be subject to the disadvantages inherent in a flammable material. It has been found that if the troublesome impurities, principally sodium and chlorides, are avoided the tendency toward corrosion is greatly reduced; and it is now known that in order to ignite magnesium practically the whole piece of metal must be raised well above the melting point (which is 650 deg. F.); hence it is evident that the metal is in much less danger from fire than many materials of construction that engineers do not hesitate to use where it is advantageous to do so. In a finely divided condition it has found a place of some importance as a dehydrating agent. The powder is added to a liquid to be dehydrated—for instance, transformer oil or aniline—and it reacts with the least trace of moisture to produce hydrogen and magnesium hydroxide. The hydrogen bubbles off and the precipitate is easily removed.

As a deoxidiser in the manufacture of many metals and alloys magnesium has found a valuable application. A metal to be strong and reliable must be clean—that is, it must contain as few non-metallic inclusions as possible. The most prevalent harmful inclusions in metals are oxides, and these can be eliminated largely by reducing them to metal by adding small quantities of metallic magnesium or another deoxidiser to the molten metal. Magnesium has a greater affinity for oxygen than the metal being treated, and the violence of its reaction with oxygen is in many cases advantageous, for the stirring effect is sometimes very important. The magnesium oxide formed in the deoxidising reaction is very light and it rapidly rises to the surface of the molten metal, where it can easily be removed. Since any excess of deoxidising material will remain in the metal, the fact that many metals are unharmed by the addition of magnesium makes it a convenient deoxidiser as well as an efficacious one. At present its cost is high for this purpose, and wide application cannot be expected until the price is lower.

Early Processes Faulty.

Until recently magnesium was for the most part produced by the electrolysis of fused magnesium chloride, to which was added fused sodium chloride and potassium chloride to maintain a low melting point of the bath. Production on a large scale was first accomplished in Germany, the raw material being obtained from the Stassfurt salt deposits. The method was not only conducive to the production of a metal containing harmful impurities but it was also fraught with serious difficulties. If the molten magnesium came in contact with the evolved chlorine, recombination took place and the accidental presence of magnesium oxide in the bath seriously interfered with the electrolysis. These and other difficulties were largely overcome by greatly complicating the process, but two great disadvantages remain: The process is discontinuous and expensive.

Many reasons have been advanced for the corrodibility of magnesium containing sodium and chloride, but the most adequate is that of Ulick R. Evans, the well-known authority on corrosion, who says:—

"Ammonium chloride has, as is well known, a considerable solvent power for magnesium hydroxide, and thus its presence will prevent the formation of a protective film. It is often stated that the same explanation cannot be extended to the case of the other chlorides (for example potassium chloride), because when magnesium is attacked by potassium chloride a copious precipitate of magnesium hydroxide appears. But although the solvent power of potassium chloride may not be sufficient to prevent the formation of solid magnesium hydroxide entirely, it may be sufficient to modify the character of the hydroxide precipitated; a substance precipitated from a solution in which it is partly soluble usually differs considerably in physical condition from the same substance precipitated from a solution in which the solubility is very low. Furthermore, it is rather to be expected that the presence of chlorides in the solution will tend to "loosen" the hydroxide, causing the compound to enter the body as a diffuse precipitate, instead of adhering to the surface of the metal as a tight protective film. Any dissolved substance which lowers the interfacial tension between the water and the hydroxide is likely to have this loosening action, and the fact that chlorides are known in many cases to have a peptising action upon precipitated hydroxides would seem to indicate that chlorides do reduce the interfacial tension between the hydroxides and the water.

New American Process.

The new process that has so greatly changed the possibilities of magnesium as a metal is a method developed by the American Magnesium Corporation for electrolysing magnesium oxide. In this process the oxide is added to a bath of fused fluorides, principally magnesium fluoride, in a specially developed electric furnace. The lining of the furnace is composed of unfused electrolyte, which, being next to the cool walls, remains in the solid state. Magnesium oxide is continuously added to the bath, while magnesium metal is removed at one electrode and carbon monoxide (the carbon coming from the electrode) is evolved at the other.

Magnesium oxide is only slightly soluble in the fluoride bath—in which respect it differs considerably from aluminium oxide—the solubility being

* Extracted from "Chemical and Metallurgical Engineering."

only about 0.1 per cent. Strictly speaking, therefore, the process is probably not a direct electrolysis of the oxide. It has been suggested that the mechanism is as follows:—

$$MgO + F_2 = MgF_2 + O$$
$$MgF_2 = Mg + F_2$$
$$C + O = CO$$

Magnesium fluoride is electrolysed, producing magnesium and fluorine. The latter immediately combines with the magnesium in solution to produce more magnesium fluoride. As this dissolved oxide is broken up, more dissolves, keeping the solution saturated. The oxygen of the oxide, which is replaced by fluorine, combines with the carbon of the electrode to produce carbon monoxide. It is evident that in metal produced by this process the presence of sodium or chlorides is practically impossible and that the detrimental effects of these impurities are avoided.

Magnesium even when produced by the new method cannot be set down as "a corrosion-resisting metal," since that phrase has come to imply a rather general corrosion resistance, but its immunity from attack by certain corrosives is of great value. It is entirely unaffected by alkalis of any concentration even when hot, and it resists perfectly the action of hydrofluoric acid. It resists ordinary atmospheric corrosion, remaining bright indefinitely unless unusually corrosive gases are present in the atmosphere. A treatment is being perfected that promises to make magnesium and its alloys highly resistant to the attack of salt water and similar "natural" corrosives. While complete information is not available regarding this treatment, it is stated that it is similar to the Z D treatment for aluminium alloys, in which the alloy when heat-treated is quenched in a solution of sodium silicate, with the result that a wear-and-corrosion-resistant surface is produced.

Advantage of Low Density.

Most of the applications of magnesium and its alloys have been made where the low density of the metal is advantageous. Magnesium has a specific gravity of 1.74, and with the addition of even 10 per cent. aluminium it is only about 1.8. Its potential value in aircraft manufacture and for moving parts of gasoline engines was obvious from the first, and its advantages for these purposes were soon utilised. Alloys have been made with many metals. Copper, cadmium, calcium, and zinc will alloy with magnesium, but for most purposes the aluminium alloys are the best. The great strength of these alloys, the readiness with which they are worked and their lightness combine to make them widely applicable. With the co-operation of the Aluminium Company of America the American Magnesium Corporation has recently completed a survey of the magnesium-base aluminium alloys in various forms.

The strength of a beam subjected to cross stress or torsion is proportional to its section modulus, which in turn is proportional to the cube of any lineal dimension of the section. Thus where bending or twisting forces are encountered, doubling the cross-section much more than doubles the strength of the member, from which it follows that a metal as strong as steel and one-third as heavy may provide a member of the same weight and much more than three times as strong.

Magnesium alloys have been suggested for moving parts in cream separators, and it is reasonable to expect that there are places in chemical engineering equipment where similar applications will be found. It is possible to make magnesium alloy parts with a tensile strength of more than 20 tons per sq. in. and a density less than 1.8. The value of this material is obvious where the inertia must be low. It has been found to serve efficiently in an unusual case of this sort where conditnons are extreme: in a "super-charger," a device for providing air at atmospheric pressure to aircraft motors when at a high altitude, the impeller (or fan blade) must turn at a rate of 27,000 r.p.m., and when the motor is started it must acclerate to this speed while the first six explosions take place in the motor. The shock to the impeller would be too great for a metal with even the strength of steel if its density and consequently its inertia were not very low.

Difficulties of Casting, Forging and Welding.

Due to the readiness with which it oxidises at high temperatures and its tendency to ignite at a little above its melting point, magnesium presents difficulties in casting and forging which preclude the use of these means of fabrication by the uninitiated, but with a little care it can be readily machined, welded or soldered. It machines more freely tha aluminium, and cutting speeds even higher than those used in working with brass may be used. The tools should be kept very sharp, but no lubricant is necessary. In welding with the oxyacetylene flame and a suitable flux, no great difficulty is experienced if proper care is taken to follow the special technique that has been developed for this material. In soldering, the same difficulties are encountered as in soldering aluminium. Surface oxides make necessary extra care, and the joint is subject to corrosion in the presence of moisture.

Troubles in the French Foundry Industry.

Of direct interest to British foundrymen is the question of cost of the freightage on iron castings, which has recently been having the attention of the Syndicate Générale des Fondeurs de France (French Foundry Employers' Federation). According to "La Métallurgie," the increase in railway charges for small castings is now seven times greater than before the war. This cost is so serious that one foundry in the Ardennes has been forced to build two more in parts distant from their central establishment in order to be nearer to the consuming market. Before the war castings were sent in open trucks, and the railway companies were responsible for breakages. Now that the tariff is seven times greater, the railways refuse to handle even unmachined castings unless they are packed in boxes, otherwise the goods are at "senders' risk." Current opinion insists that there should be a reduction, as the present price of castings cannot support it. Another factor is that certain foundries and districts are granted privileges, and there is an insistent demand that there should be a standard tariff for everybody.

The Belgian Government refused at the beginning of the year to continue the economic arrangement which was in existence. Up to now abortive discussions have taken place. The French have several reasons for fearing that the Belgian Government is not so well disposed to French interests as formerly. One would have to be blind not to perceive that both in London and Geneva the Belgian representatives have not seconded French policy, as used to be the case. Every time French views were opposed the Belgians have threatened the imposition of adverse Customs tariffs. This specially affects the French foundrymen in a small way of business.

Fears that the negotiations between France and Germany for a convenient agreement between the countries are present in the French foundrymen's minds, as they imagine their interests will be subservient to more powerful interests. Again, they are protesting against the ordering from Germany on reparation account of thousands of items of railway rolling stock, which will act adversely against their interests.

Whilst the Board of Trade returns are not very helpful in gauging the amount of work lost to British foundries by imports from the Continent, the nuisance for the British steel castings manufacturer is that every time he quotes he is up against foreign competition.

Scientific Principles of Centrifugal Castings.

In this article, which appeared in our last issue, on page 295, the illustration reproduced did not

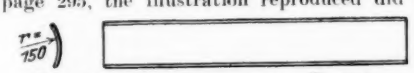

Fig. 1.—Form of Sand-cast Plates.

show up in some copies owing to an accident in printing. It is therefore reproduced above.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Phosphide Eutectic

To the Editor of The Foundry Trade Journal.

Sir,—With reference to Mr. Rowe's letter in your issue of September 25, I am interested to note his own confirmation of the feature in the phosphide eutectic in cast iron to which I drew attention in my letter in your issue of September 4.

In refreshing, before I wrote you, my memory in regard to the Continental literature of the subject of that most prolific period to which he refers (and of my close contact with which at the time I happen to have retained some proof, were that needed) I have overlooked the photograph which he quotes.

I am not in the least anxious in the matter of priority. I wrote because it is my definite experience that the pearlitic duplex nature of the constituent within the phosphide masses is not commonly known to metallurgists in cast iron.

I grant that x5,000 is not necessary to see this structure. It may be expected to be visible at the magnifications which resolve lamellar pearlite. It was observed at this magnification incidentally amongst many other matters which are in course of convenient and fruitful review, thanks to the new facilities placed in our hands in the form of the super microscope. I have some excellent photographs of it at x2,500, but perhaps the point is now sufficiently illustrated without further reproductions.

I ventured to find in Mr. Rowe's mention of the super microscope some mitigation of his "I was much amused . . . etc." and trust that you will kindly admit my view that the intrusion of such a remark is hardly in the best interests of purely technical correspondence.—Yours, etc.,

F. Rogers, D. Eng.

5, Hicks Lane, Westbar, Sheffield.

Foundry Conditions in the Irish Free State.

To the Editor of The Foundry Trade Journal.

Sir,—I note your comments on an article of mine dealing with the above subject in your issue of October 2, and venture to submit the following remarks.

Quite true, the facilities you cite are available to Irish iron founders, and you might even have pointed out that the National Physical Laboratory is still at the service of the technical trades of Ireland.

The fact remains, however, that although the foundry conditions in Ireland differ but little from those existing in the smaller English foundry centres, in practice neither the N.P.L. nor the B.C.I.R.A. appear to fit in with Irish requirements.

I may remark, in passing, that when detailing the uses to which the Experimental Foundry Laboratory in Dublin might be put, I purposely omitted research. What seems to be required, at the moment, and for several years to come (and my idea was, in the first instance, to attempt to cater for this requirement in Dublin), is an institution capable of handling routine analysis, and scientific direction, tinged with a definite educative aim, and it is plain that such a scheme must be carried out on the spot.

Research is a desirable thing, but research without the necessary foundation of routine knowledge is effort wasted. Unhappily, in the Irish Free State, this foundation is lacking, and the problem which lies before anyone seeking to benefit the trade is how best to lay the foundations of routine knowledge.

The Foundry Trade Journal must be given credit for trying to do its best in this connection, and its issues are to be found on many Irish foundrymens' tables, queries are even sent in, and courteously dealt with.

We fully recognise what is at our service, the problem however is—I repeat—How to lay the foundations! Much spade work requires doing, and that work must be done in the Irish Free State itself; when it is done, the time will have arrived to consider taking part in the activities of the B.C.I.R.A.

I quote from a letter received recently from the English representative of a very important Continental firm:—

"With regard to what you say about the position of the Irish Free State, we are inclined to agree with you in every detail. We have recently visited Ireland, and frankly we cannot understand how any foundry can live, not to mention making money, under the conditions prevailing."

You enumerate the various nations which contribute members to the Institute of British Foundrymen, and remind me that the Irish Free State is not represented, does not this fact indicate that something is lacking, and that the progress of Irish foundries has always been lamentable?

"Hewers of wood, and drawers of water." That day has passed, and we trust that after a very considerable amount of spade work, to be able to take our place amongst "French, Italians, Spaniards, Americans, Indians, Canadians, Australians, South Africans, Egyptians" and may I suggest even alongside of Germans.

It must, however, be frankly admitted that today our foundry trade is lamentable, and if the Irish Government neglect its interests as has been done in the past by British Governments, the trade will die! My greatest desire is to awaken the trade to its necessities, and the Authorities to their duties, for, while employed in a large English works, on the execution of Irish orders, I was so impressed with the need for the deseminination of metallurgical information in my country, that I determined, at the earliest opportunity, to return, and attempt to cast light on what I conceived to be one of our most dire needs.—I remain, yours, etc.

H. Grattan.

45, Synge Street,
Dublin.
October 4, 1924.

Determination of Sulphur in Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—May I add a slight correction to the sketch I described in your issue of September 25 for the determination of sulphur in cast iron.

As I pointed out the apparatus could be made up out of a wash bottle and a separation funnel, but I omitted to show the tap of the funnel in the sketch, which is essential for to prevent the escape of H_2S whilst in operation.—Yours, etc.,

"A."

Visit to New London Foundry.

Last Saturday afternoon, about 80 members of the London Branch of the Institute of British Foundrymen paid a visit to the North Woolwich foundry of Messrs. Harland and Wolff. The members spent an interesting afternoon inspecting the works, commencing with the brass foundry section and finishing the visit in the joinery shop, where tea was served. Mr. Faulkner, London Branch President, said that like most other foundries they were not getting the amount of work commensurate with the size of the foundry, but as time went on and the foundry became better known throughout the world, ship repairs of an important character would be diverted from the Tyne and Clyde to that foundry. Concluding, Mr. Faulkner thanked the works staff, especially Messrs. Mitchell and Barker, for giving up their Saturday afternoon for the benefit of their guests. Mr. Mitchell made a short reply.

The Constructional Engineering Company, Limited, of Charles Henry Street, Birmingham, have recently dispatched to Bonnybridge two cupolas of 7 ft. 6 in. diameter and 50 ft. high. Their transport necessitated special traffic arrangements on the railways. No less than 20 cupolas have been dispatched from the Titan Works during September.

Comparative Melting Tests in a Standard Cupola and a Schürmann Furnace of the Same Overall Dimensions.*

By E. Piwowarsky and N. Broglio.

It is difficult to arrive at a satisfactory judgment of the results of heating the blast in cupola-furnace work—at least, from a practical standpoint. The points of prime importance in considering this question are the various practical considerations and the very varied requirements which the cast iron has to satisfy as regards temperature and quality, but the decisive part is probably that played by the coke used in the melting operations, as this pretty largely determines the variations effected in the blast temperature. If pre-heating the blast enables the combustion ratio CO_2:CO in the waste gases to be increased still further in a cupola furnace that has already been adjusted to maximum thermal efficiency, or enables the temperature of the cast iron to be increased with the combustion ratio remaining unchanged, or the quality of the iron to be improved with the same combustion ratio and constant iron temperature, then it is certainly an advantage. Not only the heat balance, therefore, but, in the last analysis, its position in the balance of the cost of production, will be what decide as to the advisability or otherwise of pre-heating the blast.

Regarded from the mere standpoint of a saving in heat, the pre-heating of the blast does not always guarantee an attainable advantage. To take an example, let us suppose that we are dealing with such an excellent quality of coke that the combustion ratio obtained without pre-heating the

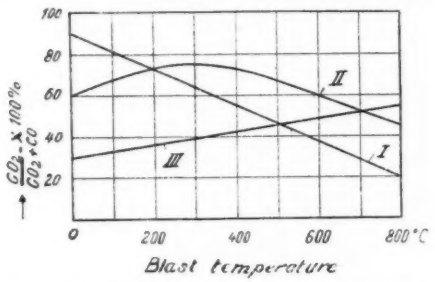

Fig. 1.—Gas Ratio Variation with Temperature when Working with Pure Carbon. Good and Bad Cokes.

blast represents the maximum attainable value in the cupola furnace in accordance with the conditions which the producer governs, then, as we can see from Curve I in Fig. 1, the CO_2: CO ratio is very little affected by the increase in blast temperature, because by increasing the combustion temperature, the equilibrium of the gases is displaced in favour of the formation of CO.

Taking a coke of medium quality (Curve II, Fig. 1), the best combustion ratio would be expected from a *definite* blast temperature. Up to this temperature, an advantage would accrue from pre-heating the blast. Any further rise in the temperature of the blast would then have the same effect as in the case of Curve I.

If the coke happened to be very bad, a gradual improvement in the combustion ratio (CO_2: CO) might be expected, or, in other words, the intensity of combustion of the coke would be so low as not to enable the blast to be pre-heated sufficiently hot. (Curve III in Fig. 1.)

We can quite imagine, on the other hand, that even where there were no advantages from the standpoint of heat economy, it might be advisable to pre-heat the blast, where, for instance, the temperature of the cast iron attainable under normal conditions would not be sufficient to cast light castings, or where the discard could be considerably reduced by the introduction of pre-heating of the blast. Finally, we may take the case of the improvement of cast iron by alloying it—a subject that is woefully neglected—where a higher temperature of the iron attainable from the use of pre-heated blast might enable alloying to be carried out with success. This possible higher temperature when used in conjunction with "pearlitic" cast iron might prove a very valuable factor in the future.

The above conclusions as regards the pre-heating of the blast must be understood to represent the quite neutral and unbiassed standpoint of the present writers.

The tests now to be described were carried out in a foundry on the Lower Rhine, in which two cupola furnaces of the same type were used, one of these being fitted with Schürmann blast pre-heaters without any alteration in the furnace dimensions. The overall height of the furnace up to the throat was—inside, 4 metres (13.1 ft.); outside, 4.40 metres (14.4 ft.). The diameter of the furnaces in both cases was 0.9 metres (35.4 in.) inside and 1.65 metres (5.2 ft.) outside. The thickness of lining was 0.375 metre (15 in.) at the sides, and 440 mm. (18 in.) at the bottom. The lining was of iron-armoured silica paste. The ratio of total cross-sectional area of blast: cross-sectional area of furnace was constant at 0.16 in

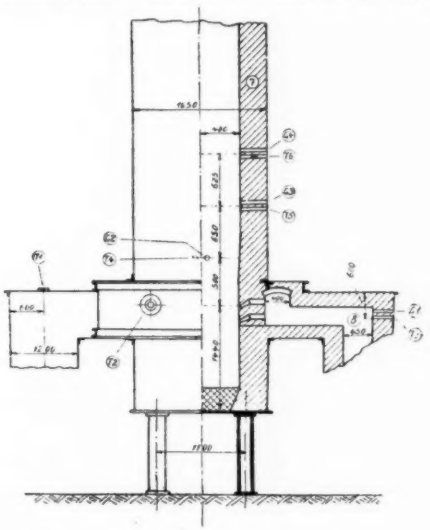

Fig. 2.—Half-section through Experimental Cupola.

the Schürmann furnace. In the normal furnace this ratio had to be kept slightly larger, because at the end of the heat the tuyeres always clog up. The ratio therefore varied between 0.20 and 0.30 (referring to the beginning and end of the run). The number of tuyeres was between 18 and 20. The blower used was of the encased type, manufactured by the Aerzener Engineering Company, and was driven by a 32-h.p. three-phase motor running at a normal speed of 955 r.p.m. The blast was supplied to the furnaces by a blast pipe 15 metres (49 ft.) long and 350 mm. (14 in.) dia. The comparative melts were made with similar charges, the same sort of coke for the same quality of cast iron, and the duration of the heat was the same in both cases. The charge was freed as far as possible from impurities (sand, etc.), so that this factor could be eliminated. Particular attention was paid to getting satisfactory samples of coke, slag, lining, etc., and the samples for the gas analysis were taken very carefully from the several zones of the furnace (the tube used was water-cooled, and was protected from any sudden surges of gas from the column of the charge by building special bridges or arches in the furnace). The following schedule shows the scope of the measurements made.

* Translated from "Die Giesserei." The authors are on the Metallurgical Staff of the Aachen Technical College.

SCHEDULE FOR THE COMPARATIVE MELTING TESTS.

Analyses.

(*a*) *Raw Materials.*—(1) Various types of iron used; (2) coke (both bed and melting); (3) dumped coke; (4) limestone; and (5) lining.

(*b*) *Finished Products.*—(1) Test-bars from the various samples tapped; (2) running slag; and (3) dump slag.

(*c*) *Gas Samples.*—(1) Waste gases at the entrance to the checkers (G1 in Fig. 2); (2) waste gases on leaving the checkers; (3) gas at 500 mm. (20 in.) height above zone of tuyeres (G2); (4) gas at 1,150 mm. (48 in.) above tuyere zone (G3); (5) gas at 1,775 mm. (69 in.) above tuyere zone (G4); and (6) waste gases at the charging door.

II.—Temperature Measurements.

(1) Blast at the blower. (2) Blast before entering the checkers. (Taken with mercury thermometer.)

(3) Pre-heated blast just before entering furnace. (4) Waste gas before entering the checkers. (Pt—Pt-Rh couple, with anti-radiation device. Checked by flow pyrometer.)

(5) Waste gas when leaving checkers.

(6) Furnace temperature through peep-holes (calibrated on the Holborn-Kurlbaum principle).

(7) Furnace temperature 500 mm. above tuyeres (position T4 in Fig. 2), carried out by Holborn-Kurlbaum pyrometer, checked by means of an Ardometer.

(8) Furnace temperature 1,150 mm. (about 48 in.) above tuyeres, by means of platinum-platinum-rhodium thermocouples, checked by Ardometer and Holborn-Kurlbaum pyrometer.

(9) Furnace temperature 1,775 mm. (69 in.) above tuyeres, as in (3).

(10) Iron in the ladle. (11) Slag temperature. (By means of Holborn-Kurlbaum pyrometer after calibration with Pt—Pt-Rh couple.)

(12) Temperature of walls of cupola furnace. (13) Temperature of walls of heating stove (for blast). (By Knoblauch pyrometer.)

III.—Weight Measurements.

(1) Coke forming part of charge; (2) smelting coke; (3) dump coke; (4) weight of charge. (All by means of a specially calibrated scales.) (5) Metal actually cast (crane scales); and (6) working and dump slag (by means of the charging weighing machine).

IV.—Miscellaneous Measurements.

(1) Quantity of blast at the blower (by calibrated volume-gauge); (2) quantity of waste gases at throat (determined from the analysis of the waste gases); (3) quantity of gas entering the checkers (as 1); (4) internal width of furnaces before and after each heat; (5) blast-pressure at entry to furnace (hydraulic-pressure gauge); and (6) power consumed by blower.

V.—Mechanical and Physical Tests, &c.

(1) Transverse, compression, hardness, impact, resistance to fatigue (continuous impact) tests; (2) shrinkage (open casting of bars 1.18 in. dia.).

VI.—Special Tests, &c.

(1) Determination of gas or oxygen content; (2) metallographic investigation.

In order to arrive at a proper basis for comparison, a number of preliminary tests were made, extending over several days, in order to determine the proportion of coke which could be taken as the minimum for getting satisfactory working conditions and material. This proportion was found to be 13 per cent. in the ordinary furnace and 8 per cent. in the Schürmann furnace, and was adhered to in all of the principal experiments. The furnaces were further adjusted by blowing with different volumes of blast on different days. By plotting the several balances for these main tests and combining them into curves, the efficiency curves for each furnace were obtained corresponding to the above-mentioned percentages of coke. In curves, Figs. 3 and 4, the thermal efficiencies, and melting yields are plotted in terms of the volume of blast passing into the furnace per minute (*i.e.*, taking into account the blast losses, amounting to 17 per cent. in the normal furnace and 22 per cent. in the Schürmann furnace).* The maximum value for the thermal efficiency thus arrived at, and which also coincides with the best yield for the above-mentioned percentage of coke, corresponds to a very definite quantity of blast blown into the furnace per minute, which for the Schürmann furnace is about 74 cub. metres (2,613 cub. ft.), and for the normal furnace, 83 cub. metres (2,930 cub. ft.). By calculating (from the figures given below) the theoretical quantity of air required, as arrived at by the quantity of coke burnt (melting coke + bed coke − dump coke) we arrive at a theoretical air consumption of 72 cub. metres (2,543 cub. ft.) per minute for the Schürmann, and 128 cub. metres (4,520 cub. ft.) for the normal cupola furnace.

From this we see that the Schürmann furnace has absorbed practically the quantity of air determined theoretically, and that the maximum on the yield curve pretty closely approaches this theoretical quantity. In the case of the standard furnace, however, it will be noticed that the maximum of the yield curve corresponds to a quantity of air blown in per minute that is well below the theoretical; *i.e.*, the coke does not absorb the blast. The quality of the coke (*i.e.*, its "intensity of combustion") was so bad (13 per cent. of ash in the dry state) that, had the theoretical quantity of air been admitted to the furnace, there was a danger of the furnace being blown cold. It is apparent, then, that the combustion ratio in the standard furnace may be expected to be bad, as, of course, a considerable part of the coke must be converted into gas in the form of CO. The hourly yield from the normal furnace at the maximum on the yield curve, with a blast consumption of 83 cub. metres (2,930 cub. ft.) per minute, and

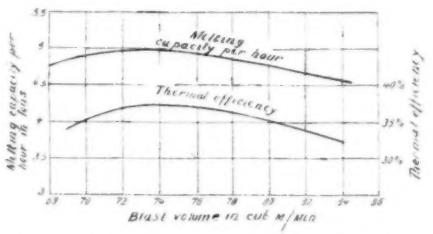

FIG. 3.—BLAST VOLUME AND THERMAL EFFICIENCY OF THE SCHÜRMANN CUPOLA.

13 per cent. of added coke, is approximately 30 per cent. higher than in the Schürmann furnace. On the other hand, with 74 cub. metres (2,613 cub. ft.) of blast, and 8 per cent. of added coke, the Schürmann furnace yields a much hotter iron (50 deg. higher on the average), with at the same time a considerably higher (80 to 100 deg. C.) slag temperature.

The experiments were carried out at a time when the works had great difficulty in getting suitable types of coke, and so were compelled to use lower quality coke for running the cupolas. We therefore have a case similar to that shown theoretically in Curve III of Fig. 1.

In comparing the metallurgical processes and the following balance of materials and heat, only the figures corresponding to the two maxima of the output curve were taken as the basis. Fig. 2 shows the main dimensions of the Schürmann furnace and the points at which the gas samples were taken (G_1, $_2$, etc.), and the points at which, after drilling through the lining or masonry of the furnace, the temperature measurements ($T_{1,2}$, etc.), were carried out. Fig. 5 is a characteristic curve of the temperatures in the two furnaces. The values measured refer, however, merely to one zone about 20 to 25 cm. (8 to 10 in.) distant from the inner lining of the furnace, and the curve does not therefore define the nature of the temperature distribution in the centre of the furnace. A

* The higher blast losses in the Schürmann furnace are explained by the fact that the construction of the test furnace was very inefficient so far as the blast pipes were concerned, owing to having been converted from a normal cupola furnace. The blast pre-heater was in this case about 6 ft. 4 in. behind the furnace, and connected with masonry-covered channels to the receiver in front of the furnace tuyeres. In more recent designs the blast pre-heater is set up alongside the furnace and connected with it direct. The blast leads are then of the same length as in a normal cupola furnace.

glance at the curves will show that the temperature in the region of the tuyeres and the melting area is 50 to 150 deg. C. higher than in the normal furnace, whereas, however, the temperature drop is much quicker. The temperature characteristic of the Schürmann furnace is the best, thermally, because, owing to the initial temperature being higher, the iron is hotter; on the other hand, the gases of combustion penetrate more quickly into the colder regions of the furnace, owing to the pronounced temperature drop, and these colder zones are much more favourable to the persistence of the carbon dioxide. In this way the combustion ratio, good at the start, which has already

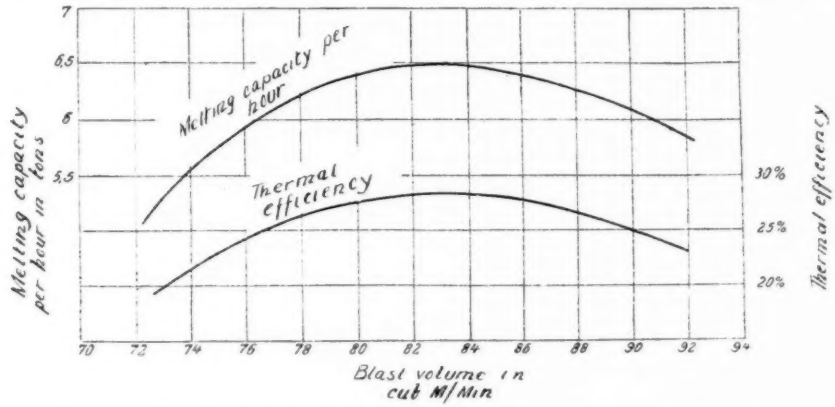

Fig. 4.—Blast Volume and Thermal Efficiency of Standard Cupola.

set in just above the tuyeres, is not further impaired to any extent. The smaller depth of the various layers of coke as compared with the standard furnace has much the same effect. The actual melting zone in the Schürmann furnace is about 600 mm. (25 in.), as compared with 900 mm. (47 in.) in the standard furnace. If, as already mentioned, the shallower melting zone and the quicker temperature drop in the Schürmann furnace have a good effect on the combustion ratio, there is the additional advantage that an appreciable part of the gases of combustion (one-quarter to one-third, according to the degree of preheating of the blast and working conditions) are

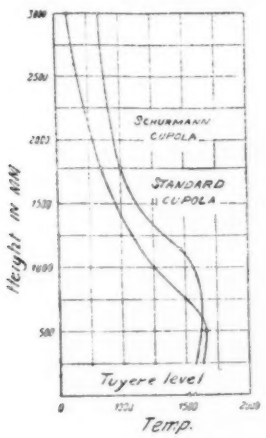

Fig. 5.—Comparative Temperatures with Increasing Height.

withdrawn from the source of heat by passing into the masonry pre-heaters, and so avoid the decomposition of the carbon dioxide by the incandescent coke, and are thus very thoroughly utilised thermally.

The analysis of the gas before passing into the pre-heater at the point G_1, Fig. 2, gave the following average as the result of these tests:—CO_2, 15; CO, 0.5; and oxygen, 7 per cent.

The blast temperature just before entering the furnace of the checkers was about 25 deg. C. The temperature in the receiver (T_1 or T_2) when receiving waste gas was, on the average, 1,200 to 950 deg. C., and when receiving the blast before entering the cupola, 950 to 500 deg. C., the first figure referring to the commencement and the final figure to the end of a given period. The duration of a period was from 8 to 12 minutes. The temperature in the waste-gas pipe above the pre-heaters was, on the average, 275 deg. (250 to 300 deg. C.). The temperature curve at the throat during the duration of the melting periods was in all tests of the same type. It is shown graphically for the two comparative heats in Fig. 6. Figs. 7 and 8 show the variation of the gas mixture with the height of the furnace, Fig. 7 being for the normal and Fig. 8 for the Schürmann furnace. The iron and other losses and gains derived from the weight of materials tests, taking into account all the main experiments, came within the following limits:—

Comparative Percentage.

Table I.—*Metallic Losses (except Sulphur where gains occur).*

	Schürmann Furnace. Per cent.	Normal Furnace. Per cent.
Iron	..0.75 to 0.96	0.70 to 0.80
Manganese	.. 22 to 30	21 to 28
Carbon	.. 12	5
Silicon	.. 15 to 18	14 to 18
Phosphorus ..	.. 0 to 6	0.2 to 5
Sulphur	..+30 to 50	+70 to 95

The figures for two comparative heats are shown in Table II.

Table II.—*Two actual casts compared for Metallic Losses (and Gains).*

	Schürmann Furnace. Per cent.	Normal Furnace. Per cent.
Iron	0.71	0.69
Carbon	3.80	0.30
Manganese	22.50	21.00
Silicon	15.00	14.00
Phosphorus	7.00	0.80
Sulphur	+50	+81

The total loss in the Schürmann furnace was 1.06 per cent., and in the normal furnace 0.99 per cent.; both figures referred to the metallic charge.

The sulphur gain in the Schürmann furnace is considerably lower, and is due to the lower percentage of coke charged, to the temperature in the melting zones, and the higher percentage of air blown into the furnace.

The power consumption of the blower per ton of iron melted was 2.1 kw.-h, in the Schürmann furnace. With the same output, the normal furnace consumed about 1.7 kw.h. The additional consumption was therefore 18 per cent. This, however, is no specific property of the Schürmann furnace, but is connected with what was said about the blast losses in the footnote on page 306. Assuming the same blast losses, the power consumed would have been the same in both cases.

In drawing up the heat balance, the conduction and radiation losses were not determined as a difference, but were calculated direct from heat through-put. The mean shell temperatures of the furnaces, as determined by contact pyrometers, are shown in Table III.

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TABLE III.—*Shell Temperatures in Deg. Cent.*

	Schürmann Furnace.	Standard Furnace.
Bottom zone ..	..152 (1550)	143 (1550)
Melting zone ..	..158 (1700)	132 (1700)
Middle zone ..	..118 (1200)	130 (1300)
Throat zone ..	.. 60 (600)	75 (850)

The figures in parentheses are the temperatures at the inner walls upon which the above calculations were based. The mean value of the conduction and radiation losses were therefore found to be:—For the Schürmann furnace, 2,201, and for the standard cupola 2,306 kg.-calories per sq. metre per hour.*

To these radiation losses has to be added a value representing 3 to 6 per cent. of the balance for open radiation losses (opening and cleaning the tuyeres, blowing off the hot furnace gases after each slag-tapping operation, etc.).

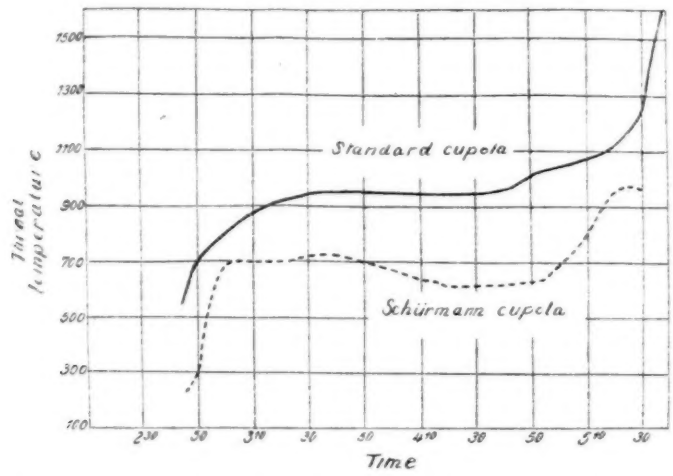

FIG. 6.—COMPARATIVE THROAT TEMPERATURES OF THE SCHÜRMANN AND STANDARD CUPOLAS.

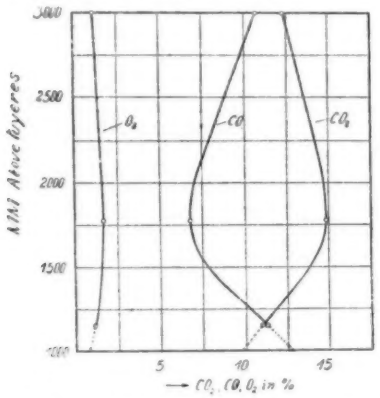

FIG. 7.—COMPOSITION OF GASES WITH INCREASING HEIGHT.

The charge of the two main heats used for the experiments are shown in Table IV.

TABLE IV.—*Comparative Charges Made.*

	Schürmann Cupola	Standard Cupola.
Hematite Pig-iron	..1.725 metric ton	2.600 metric ton
Deutsch III ..	..1.725 ,,	2.250 ,,
Luxemburg ..	..1.525 ,,	1.275 ,,
Machine scrap	..2.300 ,,	3.150 ,,
Own scrap ..	..4.945 ,,	5.730 ,,
Furnace scrap ..	..0.465 ,,	0.465 ,,
Siegen gray pig	..0.535 ,,	0.850 ,,
"Silver" (white) pig ..	—	0.200 ,,
Low carbon iron ..	—	0.100 ,,
Steel scrap ..	—	0.100 ,,
Ferro-silicon	..0.640 ,,	0.780 ,,
Total ..	12.960 ,,	17.500 ,,
	(12.861)	(17.320)

The figures in parentheses show the yields from the two heats. The net blast period in the Schürmann furnace was 158 minutes, and in the normal furnace 161 minutes.

The average analysis of the coke was always the same in all tests, except for very slight and negligible differences. Table V gives the figures for the two comparative heats.

TABLE V.—*Comparative Coke Analyses.*

	C per cent.	Fe per cent.	S per cent.	Ash per cent.	Moisture. per cent.
Schürmann cupola	80.26	1.26	1.29	10.48	6.76
Standard cupola ..	80.19	1.21	1.30	10.40	6.70

Table VI shows the coke consumption for the two principal heats.

TABLE VI.—*Comparative Coke Consumption in Metric Tons.*

	Bed coke.	Melting coke.	Total coke.	Damp coke.	Total consumption.	Total con. per ton melted %
Schürmann furnace ..	725	1,105	1,830	225	1,605	13.0
Normal furnace ..	750	2.275	3,025	145	2.880	16.6

From this we see that the Schürmann furnace shows a saving of melting coke of, roughly, 51.5 per cent. and a total saving of coke of 22 per cent.

The average analysis of the working slag is shown in Table VII.

TABLE VII.—*Comparative Slag Analyses.*

	SiO_2	Al_2O_3	CaO	MgO	FeO	MnO	P_2O_3	SO_3
Schürmann	47.8	6.60	28.9	1.6	11.2	3.0	0.45	0.1
Normal ..	47.90	6.80	28.1	1.3	11.8	2.0	0.48	0.1

Table VIII gives the dimensions of the furnaces before and after the principal tests, as well as the extent of increase after each test. These increases serve to show the extent of expansion of the actual melting zone.

TABLE VIII.

		Internal width at the melting zone.		Height of melting zone.
	Test	Before.	After.	
			mm.	mm.
Schürmann ..	1	960×980	1,000×1,020	650
,, ..	2	980×1,020	1,020×1,060	645
,, ..	3	1,000×1,040	1,040×1,080	595
,, ..	4	950×1,000	980×1,010	675
,, ..	5	1,000×960	1,040×1,000	600
Normal furnace	1	980 (round)	1,030 (round)	850
,, ,,	2	950 ,,	1,010 ,,	900
,, ,,	3	975 ,,	1,020 ,,	850
,, ,,	4	980 ,,	1,050 ,,	950

NOTE: 25.4 mm. = 1 inch.

* Approximately four B.T.U.s equal one calorie.

The following are the heat balances of the two furnaces:—

(*a*) *Heat Balance of the Standard Cupola Furnace.*

Incoming:		
Latent heat of coke	18,616,320	kg. cals.
Combustion of accompanying iron	983,512	,,
Heat of charge (iron, coke, lime, and blast)	215,947	,,
Exothermic reactions	5,088	,,
Total	19,815,867	
Outgoing:		
Heat contents of the molten iron	5,629,000	,,
Heat contents of slag	734,751	,,
Waste Gases in Stack, perceptible	4,723,310	,,
,, ,, ,, ,, latent	7,736,457	,,
Conduction, radiation, and losses due to escape of gases	464,776	,,
Endothermic reactions	396,453	,,
Calories lost when emptying furnace	131,120	,,
Total	19,815,867	,,

(*b*) *Heat Balance of the Schürmann Furnace.*

Incoming:		
Latent heat of coke	10,374,720	kg.-cals.
Combustion of accompanying iron	991,591	,,
Heat of charge	160,036	,,
Exothermic reactions	3,865	,,
Total	11,530,212	,,
Outgoing:		
Heat content of the molten iron	4,232,083	,,
,, ,, ,, slag	615,750	,,
Waste gases at stack, perceptible	2,343,897	,,
,, ,, ,, latent	1,130,565	,,
Drawn off for pre-heating the blast at the receiver (tuyere zone)	2,112,077	,,
Endothermic reactions	269,232	,,
Losses due to walls, radiation and blowing out, etc.	548,088	,,
Kg.-calories lost when emptying furnace	278,520	,,
Total	11,530,212	,,

As the heat contents of the liquid iron, the amount taken as a basis for the calculation was 325 kg.-calories, and as heat content of the liquid slag, 500 kg.-calories. On the basis of the heat

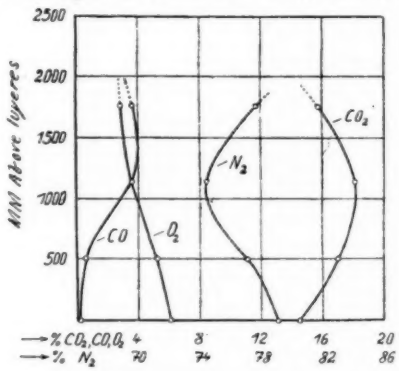

Fig. 8.—Composition of Gases with Increasing Height.

balance, and referring the thermal to the relation:

$$\frac{\text{Heat Contents of the Iron produced, in kg.-cals.}}{\text{Calories, perceptible and latent, put in to the system,}}$$

we obtain, for the normal furnace, the following thermal efficiency:—

$$\frac{5{,}629{,}000}{19{,}815{,}867} \times 100 = 28.5 \text{ per cent.}$$

and for the Schürmann furnace,

$$\frac{4{,}232{,}083}{11{,}530{,}212} \times 100 = 36.7 \text{ per cent.}$$

The foregoing heat balances show that the Schürmann furnace is decidedly advantageous from the thermal standpoint in the case under consideration. The increase in thermal efficiency amounts to 8.2 per cent., or, compared with the efficiency of the normal furnace, 28.7, or, say, 30 per cent. With longer heats, this value would increase with diminution in the ratio of bed coke to total coke used. Although in the literature we find references to cupola furnaces with efficiencies of 50 to 60 per cent., it is well to point out that these efficiencies have been calculated differently or incorrectly. The expression of the efficiency by the factors used certainly does give the lowest efficiency, but it is free from many of the uncertainties inherent in other methods of expressing it, and is to be preferred.

The balances show that it is chiefly the value of the perceptible and latent heat lost in the chimney-stack which decides the thermal efficiency of a cupola furnace. Therefore, all means which tend to decrease throat temperature and increase the combustion ratio $CO_2 : CO$ are open to discussion in as far as they apply to cupola furnaces.

Tests for the Mechanical and other Properties of the Cast Iron Melted.

The values given below are average values from at least three test bars of any one melt. The bars were cast upright in an open mould. Any figures arrived at from faulty castings or the like were rejected.

	Schürmann furnace. Tons/sq. in.	Normal Furnace. Tons/sq. in.	
(*a*) Transverse strength:			
Cylinder iron	27.4	24.4	
Iron for pipes	24.8	21.2	
High silicon	23.6	22.0	
Machine castings	23.3	21.0	
(*b*) Deflection:			
Cylinder castings	7.2	6.8	millimetres
Iron for pipes	6.6	6.5	,,
High silicon	7.5	7.2	,,
Machine castings	6.8	6.6	,,
(*c*) Hardness (Brinell):			
Cylinder castings	216	210	
Iron for pipes	230	220	
High silicon	198	196	
Machine castings	207	206	
(*d*) Notch Impact Strength:			
Cylinder castings	0.6	0.52	mkg./cm.^{2}
Pipe castings	0.49	0.34	,,
High silicon	0.57	0.49	,,
Machine castings	0.62	0.50	,,
(*e*) Fatigue test (continuous impact):			
Cylinder castings	183 blows	165 blows	
Iron for pipes	106 ,,	83 ,,	
High silicon	145 ,,	113 ,,	
Machine castings	156 ,,	136 ,,	
(*f*) Compression strength* (mean)	31.8—34.8	29.5—33.0	

The transverse strength was determined on bars 30 mm. (1.2 in.) dia., at about 24 in. centres. The casting skin was left. The hardness test was made with a ball 5 mm. dia. and 1 metric ton pressure. The notch-impact strength was tested with a Charpy 10-kilogrammetre pendulum impact tester at 4-in. centres, and on bars 20 by 20 by 100 mm. ($\frac{3}{4}$ in. by $\frac{3}{4}$ in. by 4 in.), without a notch. The scale was removed during the machining of the bars. A Krupp continuous shock-testing machine was used for the fatigue tests.

The fracture of the bars coming from the standard cupola furnace was appreciably coarser than that of the bars made with metal from the Schürmann furnace. Corresponding to this, the micro examination on unetched sections exhibited slight coarsening of the graphite lamellæ in the samples from the standard furnace. The gas content was determined on some of the samples by the hot extraction method, and gave the figures shown in Table IX.

Table IX.—*Cubic centimetres of gas evolved per 100 grammes of metal with the two types of cupolas.*

	Schürmann. cupola.	Standard cupola.
CO_2	6.3 to 7.0	7.1 to 7.6
CO	143.0 to 197.0	79.7 to ?
H_2	19.1 to 29.5	17.3 to 20.1
N_2	6.6 to 6.7	16.5 to ?

We, therefore, get an oxygen content of 0.148 to 0.158 for the Schürmann, and of 0.071 for the standard furnace, these figures representing weight per cent.

The finer formation of the graphite and the better mechanical properties of the Schürmann furnace iron are obviously a result of the higher

* The tensile strength varied between 19 and 24.5 tons/sq. in., the higher figures being generally found for the Schürmann furnace.

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oxygen content. This observation finds confirmation in the results already given in the literature on the influence of oxygen in grey cast iron. As regards any possible formation of blowholes, no differences could be found in the two products. On the other hand, the shrinkage in the Schürmann furnace metal was 0.90 to 1.12 per cent., as compared with 0.85 to 0.99 per cent. for the normal furnace metal. This also is connected with the oxygen content of the iron, as it is a well-known fact that shrinkage in cast iron increases with increasing oxygen content.

Summary.

Tests on a standard cupola furnace and on a Schürmann furnace of the same main dimensions, under comparable working conditions, and using low-quality coke, gave the following results:—(1) The Schürmann furnace had a 30 per cent. higher thermal efficiency; (2) the total metallic losses and the power consumed per ton yield were practically the same in both cases; (3) in the Schürmann furnace the iron was 50 to 60 deg. C. hotter and the slag 80 to 100 deg. C. hotter than in the standard furnace; (4) the oxygen content of the iron from the Schürmann furnace is higher, and hence (5) the mechanical properties of the Schürmann furnace iron are better.

Company News.

Glenboig Union Fireclay Company, Limited.—Dividend for year, 15 per cent., less tax.

Luton Iron Foundry, Limited, 244, High Holborn, London, W.C.—Capital £10,000 in £1 shares.

Bilston Slag Company (1924), Limited.—Capital £10,000 in £1 shares. Manufacturers of and dealers in slag, etc.

Bell's United Asbestos Company, Limited.—Interim dividend on ordinary shares, 6d. per share, being 2½ per cent. (actual), less tax.

Vulcan Foundry, Limited.—Dividend, 7½ per cent. on ordinary shares for year; repairs and depreciation, £14,340; transferred from reserve for maintenance, £25,000; carry forward, £125,421.

Sprague Meter Company, Limited, Dreadnought Works, Leam Street, Leamington.—Capital £10,000 in £1 shares. Manufacturers of meters, etc. Directors: H. H. Sprague and R. S. Wortley, junr. (managing director).

Tata Iron and Steel Company, Limited.—Gross profit (£499,500), Rs. 74,93,000; brought forward (£26,961), Rs. 2,53,927; total (£526,461), Rs. 77,46,927; debenture and loan interest (£290,733), Rs. 43,61,000; depreciation (£200,000), Rs. 30,00,000; total (£490,733), Rs. 73,61,000; carried forward (£25,728), Rs. 3,85,927.

Hardy Patent Pick Company, Limited.—The thirty-fourth annual meeting was held at Sheffield on Tuesday, the chairman (MR. C. BAINBRIDGE) presiding. The report and balance-sheet, as presented, were adopted. The election of Mr. T. G. Jameson as a director was confirmed. Mr. C. Bainbridge was re-elected as a director.

William Beardmore & Company, Limited.—Net loss for year, £68,071; brought forward, £762,564; credit balance, £694,492; interim dividend to June 30, 1923, on preference shares (free of tax), £43,200; dividend 5 per cent. per annum on preference shares for half-year to December 31, 1923 (free of tax), £43,200; carried forward, £608,092.

Bengal Iron Company, Limited.—Net profit, including £22,465 brought forward, £321,380; depreciation and colliery sinking fund, £56,456; debenture interest, £42,000; amount written off debenture issue expenses, £2,400; taxation reserve, £12,700; general reserve, £15,000; preference share dividend, £18,750; dividend on preference shares for half-year to March 31, 1924, £18,750; dividend on ordinary shares, 7 per cent., £110,250; carried forward, £45,073.

Thos. W. Ward, Limited.—Credit balance, £126,998; brought forward, £17,682; four quarterly dividends on first preference shares, less tax, £5,812; ditto, second preference shares (old issue), free of tax, £12,500; ditto (December, 1923, issue), free of tax, £3,000; ditto, employés' shares, free of tax, £1,682; interim dividend on old ordinary shares, 3¾ per cent., £22,500; final dividend on old ordinary shares, 6¼ per cent., making 10 per cent. for year, free of tax, £37,500; dividend on 125,000 new ordinary shares (December, 1923, issue), 10 per cent. per annum, free of tax, £5,789; final dividend on employés' shares, 5 per cent., making 10 per cent. for year, free of tax, £1,582; reserve fund, £25,000; carried forward, £29,313.

J. Brockhouse & Company, Limited.—MR. J. T. BROCKHOUSE, J.P., presided over the twenty-seventh annual meeting of this company, held at the Victoria Works, Hill Top, West Bromwich. In moving the resolution, the chairman said when he and Mr. Hanson took over the reins, about three years ago, they were determined to put the company on as solid a foundation as possible, and he thought the shareholders would agree that they were working on the right lines. With the many extensions the company had made in recent years and the varied nature of the articles they now manufactured, the shareholders could feel that, while there might be fluctuations in seasonable trade—while there was a lull in one section they might be busy in another, and so able to keep the continuity of their trade; find fairly regular employment for their workpeople, and, he hoped, make fairly regular profits.

Thos. W. Ward, Limited.—The annual meeting of shareholders was held at Sheffield on Tuesday. Mr. Joseph Ward, J.P. (chairman), who presided, in moving the adoption of the accounts, said: The extension referred to at our last meeting regarding the new works at Inverkeithing has been completed. These new and important works represent a good portion of the new issue of capital. The property covers about sixty acres, fifty of which is water. Some extent of the value of the premises may be gathered from the fact that your Company has constructed during the last two years 1,500 ft. of piled berths and a deep water berth of 500 ft. in length for accommodating the larger vessels. Seventy thousand cubic yards of dredging has been done, in addition to "filling" work of a similar quantity, and new railway sidings have been constructed about a mile and a half in length. We have room to provide 1,250 ft. further berthing accommodation if necessary. The whole of this work has been carried out under the supervision of one of your own local directors, Mr. F. R. Stagg. The tar slag works at Chatterley (also referred to at our last meeting) have been completed, and operations were commenced there some six months ago, and are proceeding, with gradually increasing output. Our employés on June 30 numbered approximately 2,450, 350 less than 1923, but 210 more than 1922. Practically the whole have been kept fully at work during the year. The total wages paid amount to £340,000. Amounts paid for health and unemployment insurance and workmen's compensation for the year totalled £15,470, as against £12,674 for 1923, an increase of £2,796. We have paid for railway carriage about £262,000, which is really labour. A general reduction of railway rates—and especially upon raw and semi-raw materials—is very much needed by the coal, iron and steel industries of this country, and would help them materially to meet the keen competition of foreign manufacturers. We are rapidly getting through the dismantling of the block purchase of Admiralty ships, and by the end of the current financial year we expect all to be finished. A large quantity of obsolete merchant tonnage has come into the market during the last two years, but, unfortunately, instead of these vessels finding their way to British shipbreaking yards, they have been purchased—at what are prohibitive prices to English buyers—by foreign competitors, particularly Germany, owing to the conditions brought about through the deflated exchange, less wages and longer hours. The remarkable fact in this business is that whilst our foreign competitors have given such prohibitive prices for obsolete ships, a large quantity of the scrap resulting from the demolition of the same has found its way back to this country. The imports of scrap during the last twelve months have been exceedingly large, something like 400,000 tons, an average of about 33,500 tons per month.

British Railway Contract in Spain.—Considerable importance attaches to the award to a British syndicate of the contract for the construction of a railway line to be built from Santander to Calatayad via Burgôs and Soria. The tender accepted is that of a British group on whose behalf Sir Lionel Phillips has personally been conducting negotiations. The new line will provide direct through communication between Santander and Valencia, that is between Atlantic and Mediterranean ports. The concession granted provides for a guarantee by the Spanish Government of interest at the rate of 5 per cent. on a capital of about 348,000,000 pes. (say, £11,440,000) for a period of 99 years. It is understood that an English company will be formed under the ægis of the Central Mining and Investment Corporation, and Messrs. Bernard Scholle & Company to carry out the contract. Apart from the opening afforded by the concession for the profitable employment of British capital, it is hoped that British trade may successfully compete for a fair share of all equipment which Spain may be unable, or in a less favourable position, to supply.

The Metallurgy of Aluminium.—V.

By F. A. Livermore,

The Founding Process.

There is no problem in metallo-technology which appears on the face so simple and which is, in reality, often so difficult as the production of sound castings. The alloys have their own peculiarities both as regards moulding and casting, and although many iron founders are under the impression that the metal and its alloys are difficult to cast, provided proper attention is taken of the differences attending the metal, the iron moulder can adapt himself in a very short time to either tub or bench moulding. Of the many metals and alloys, aluminium can scarcely be said to be the most difficult to cast, and incidentally none is less liable to scabbing. The tendency to scabbing increases in proportion as the melting point of a metal rises.

The melting point of steel is about 1,400, cast iron 1,200, brass 1,080, and aluminium 650 deg. C.; thus steel comes first, due to the intense casting temperature, cast iron next, brass follows, and aluminium with a melting point of less than half that of steel has, providing all the conditions of moulding are the same, comparatively no danger of scabbing at all.

Care of Crucibles.

It takes an experienced man and one well acquainted with the tricks of the trade to assist him in dealing with the subject, and this may serve as an excuse for entering at length on a somewhat threadbare topic. Very considerable improvement has been made in aluminium and aluminium alloy castings of recent years, but many problems in melting constantly arise, and the melting is equally if not more important than any other operation. Most aluminium foundries use either plumbago or salamander crucibles for

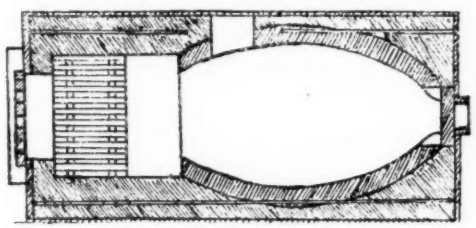

Fig. 8.—Plan of Reverberatory Furnace for Melting Aluminium.

melting. For this reason some obvious and elementary precautions that require to be observed are outlined in order to obviate loss caused by improper handling. Plumbago or graphite crucibles will absorb moisture up to 10 per cent. of their weight (in moist and foggy weather), therefore they should be stored in a warm, dry place. Before accepting a batch of crucibles it is customary to tap the side of the crucible; the good give a clear ring, the faulty are easily separated and should be returned for replacement.

In the case of crucibles of 40 to 100 lbs. capacity, they should be subjected to a temperature of about 200 deg. C. for at least 48 hours before use, 120 to 250 lbs. capacity about 70 hours, and the larger types at least 100 hours; if longer time can be afforded, it will be much better for the life of the crucible. This airing can be carried out at the back of the furnaces, over flues at the side of core stoves, or even in the core stove itself, provided the crucibles are not above or near drying cores, as the moisture given off from the cores is readily absorbed by the crucibles.

A prevalent source of trouble is in the use of tongs of a radius different from that of the crucible. The tongs should evenly grip the crucible all round, and not impinge at the two extremities only, otherwise the uneven pressure will cause the crucible to split.

Again, when withdrawing crucibles from a pit furnace, care should be taken to see that live coke or carbonaceous residue is not adhering to the underside, as when the crucible is set down the coke is crushed against the base and may damage the crucible. To prevent this it is customary to use a stool upon which the crucible stands.

The cracking of crucibles is often caused by the mistaken notion that once a crucible has been annealed and worked it may be put aside and allowed to cool down and be put into work days later. This is entirely a misconception; crucibles must be kept in a warm, dry place, whether in work or not in work. Since the crucible is mainly composed of carbon, unless the glaze is thoroughly brought out during the annealing, no protection is offered to the walls of the crucible, and the heat of the furnace would cause oxidation and subsequent disintegration.

Melting Conditions.

In charging the crucible, only metal of suitable sizes should be permitted, and wedging of the metal must not be practised, as this may on expansion cause a fracture in the walls. Molten metal must not be left to solidify in the crucible after casting, but should be poured up into ingots; any oxide or dross remaining around the sides is removed whilst hot before re-using the crucible. It is the practice of some foundries to line their crucibles—preferably with clay—in order to obviate the possible corrosion with the crucible.

Aluminium and its alloy can be melted in clay or sand crucibles; the crucibles are lined with a paste of lamp black in molasses; the lining is

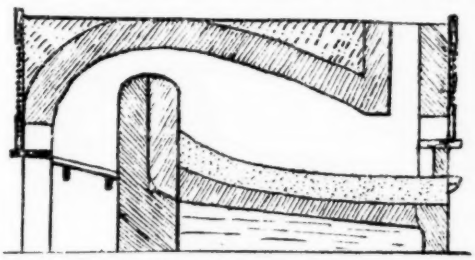

Fig. 9.—Section through Fig. 8.

applied evenly and dried very slowly at a temperature of about 300 deg. C. Aluminium melts very slowly, due to its high specific and latent heats. The metal is introduced into the crucible little by little; the fusion is advanced by agitating the mass or carefully compressing the metal with a clay-covered iron rod.

Gates and sprues from castings before being re-melted must be freed from sand, as that material is reduced to silicon and weakens the alloy. In charging the crucible care must be taken to see that none of the metal projects above the crucible; this obviates the risk of exposing the metal to the flame, and minimises oxidation. In cases where there is danger of introducing sand, it is found beneficial to add a powdered flux consisting of 20 fluorspar, 70 potassium chloride and 10 per cent. ammonium chloride intimately mixed. Such a flux tends to dissolve the silicon formed and so keep it from dissolving in the aluminium. No carbon or carbonaceous covering should be used on the metal, as carbon combines with the alloy, forming a very brittle constituent. A tough film of oxide often surrounds borings, turnings, chips and other aluminium scrap, and makes it extremely difficult for melting. This oxide can be dissolved off by heating with the alkali earths, and the British Aluminium Company, Limited, recommends the following process:—

The oxidised scrap is intimately mixed with varying amounts of a flux, consisting of 85 per cent. of common salt and 15 per cent. of fluorspar, depending upon the degree of cleanliness of the chips, and the whole is melted at a fairly high temperature. Special precaution should be exercised when melting the heat to prevent overheating,

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as this appreciably affects, and, in fact, is decidedly injurious, to the working properties of the metal. The following is also recommended as a good flux for oxidised metal:—"A mixture of 60 per cent. of potassium chloride and 40 per cent. of cryolite."

Melting Furnaces.

The types of modern furnaces for melting aluminium are various. They are charged with solid or gaseous fuel or electric current. Some years back the metal was extensively melted on the bed of a reverberatory furnace, the hearth of which was protected by layers of bauxite well rammed together, but later basic magnesite bricks were substituted similar to those used in the basic open-hearth furnace, since they showed greater resistance to corrosion. The molten metal was run off from the tapping hole into iron ladles or graphite receivers and poured from these media into the moulds. The use of the reverberatory furnace for the melting of aluminium was attended by obvious and well-recognised objections, and consequently now it is very seldom, if ever, used for this purpose.

The Pit or Hearth Furnace.

The pit furnace is very popular with most aluminium foundries of to-day. Whilst there are a great number of patented designs on the market, the old-fashioned simple pit-furnace is very difficult to improve upon, provided that it is properly designed and worked.

Fig. 9 shows the general construction of a pit furnace and Fig. 10 the Wigley patent furnace bottom, for which is claimed something like 33⅓ per cent. saving in fuel.

The size of the furnace will vary with the size of the crucibles employed, but it should be designed

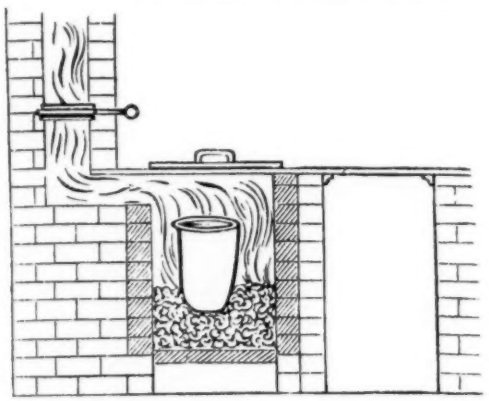

Fig. 10.—Pit Furnace.

to hold only one at a time. If arch bricks are obtainable, circular furnaces are more economical in fuel, because the corners of the square furnace which are filled with coke represent so much waste heating power. The furnace is connected to a stack of such dimensions as will carry off the gases and cause a good draught; this is necessary to ensure adequate combustion of the coke. The draught intensity is generally regulated by a damper, a form of which is illustrated in Fig. 11. The furnace bottom is just as important, since, if insufficent oxygen is provided, the furnace becomes a gas producer on a small scale, and the escaping flue gases will be rich in carbon monoxide. Each part of carbon monoxide represents a loss of two-thirds of the heating power of the coke from which it is formed.

When coke-fired furnaces are used it is best to arrange them in the form of a battery or range, built compactly together, because in this method radiation losses are reduced to a minimum, quick and easy cleaning of the ash-pit is facilitated, space is economised, and the operations centralised. It is preferable to have the furnace tops arranged on the level of the working floor, a suitable sized pit being left to allow access to the ash-pit and firebars for raking and cleaning out the ashes and unused cokes. When under the supervision of a reliable man very good results can be obtained with these furnaces. Temperature is the main factor, and requires much attention: in this type of furnace the possibility of overheating with subsequent burning is likely, and must be carefully guarded against. Again, since the metal has a great affinity for oxygen and very quickly absorbs gases at temperatures above the melting point unless the necessary care is taken during the melting operation, and the metal is cleaned just before pouring, the occluded gases will form blow-holes and honeycombing in the interior of the casting, the oxide will be present as included dross, thereby materially impairing the mechanical properties of the casting. A 90-lb. pot can be melted in 45 minutes in this furnace.

Gas-fired Furnaces.

The marked success achieved by furnaces employing coal gas as a fuel in the heat treatment of metals such as steel is proving of great assistance in the introduction of gas-fired melting furnaces for the metals in general, and especially aluminium and its alloys. Although it cannot be said that it is fully established, yet it has distinct advantages over the solid fuel method. There is no accumulation of ashes, the furnace is kept much cleaner and allows of better control in melting, the labour costs are reduced, but the cost per unit of gas is sometimes so high that it is problematic whether it is economical for continuous melting.

Quite a number of designs are on the market manufactured by such notable furnace firms as the Richmond Stove Company: Fletcher, Russell & Company, Limited, Warrington: John Wright & Company, Limited, of Birmingham, and so on.

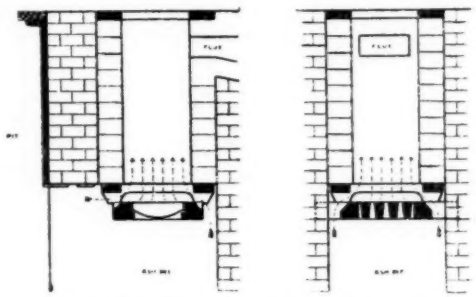

Fig. 11.—Wigley's Furnace Bottom Arrangement.

Fig. 12 illustrates a type of gas-fired furnace by Dr. C. M. Walter, of the City of Birmingham Gas Department Research Laboratories. It consists of a firebrick lining built up in sections to have a cylindrical core to suit the size of the pot to be used. The whole of the lining is contained in a box constructed of cast-iron plates bolted together loosely so as to allow freedom for expansion and contraction. The outer case is lined with firebricks and the space between the wall and lining is packed with some non-conducting material. The plate forming the furnace is supported on brick piers in the furnace pit. The furnace bottom consists of a plug of ganister mixed with broken firebricks which can be removed for cleaning or removing spilt metal. The pot rests on a firebrick slab. The high pressure injector burner enters the combustion space tangentially ½ in. below the bottom of the pot, and the flame forms a spiral round the pot, the waste gases passing away through the flue; the escape is controlled by a damper.

Oil-fired Furnaces.

On the introduction of oil as fuel for metallurgical furnaces, its many advantages were realised as a medium for the melting of aluminium. Among the advantages in the use of oil are positive control of melting, rapidity of melting, much smaller cost in furnace repairs, absence of ashes, reduction in labour costs, economy in handling as compared with coke. Furnaces for aluminium are of the lift-out type, designed similar to the illustration of the gas-fired furnace; a burning oil spray burner being applied tangentially at the bottom, so that the flame passes spirally round the crucible; the air pressure required for the oil spray is derived from a small blower.

The Electric Furnace.

No doubt the electric furnace is the cleanest, most reliable and efficient medium for the melting

of aluminium and its alloys. High initial cost is the main prejudice raised against its introduction into many works, and conjointly the supposition that the electric furnace is only in its experimental stages of production. Yet in reality the furnace is a definite commercial proposition when comparative data of this furnace with that of other types are studied.

One type is illustrated in Fig. 13, and either direct or alternating current may be used and the furnace made as a fixed or as a tilting mechanism. It consists of a framework of diatomite bricks held together by a thin casing of iron, the external dimensions 2 ft. 6 in. dia. and 1 ft. 3 in. high, a

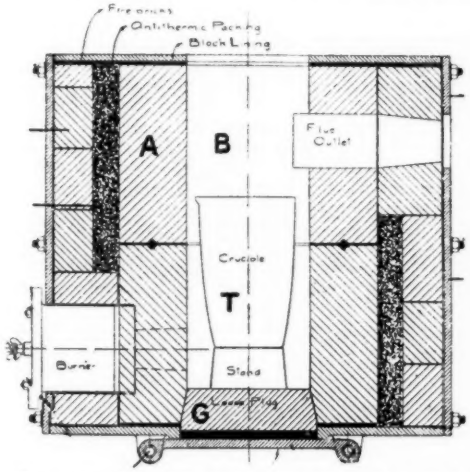

Fig. 12.—Dr. Walter's Gas-fired Crucible Furnace.

nichrome pot 1 ft. 3 in. dia. and 1 ft. high, surrounded by the electrical field, is secured to the brickwork by a thin layer of alundum cement. The top of the furnace, made of common firebrick encased in an iron casting, is conveniently secured to the base by means of swivel bolts and pins, and is easily detachable; a cap is fitted to the top of the furnace, through which a pyrometer can be lowered into the molten metal. A reducing atmosphere is maintained round the pot to prevent oxidation. An important feature of the furnace is the automatic temperature control regulator, which ensures even heating and prevents overheating with subsequent burning; this control is effected by an electric cut-out through the resistance. The furnace is expected to cost nothing in upkeep for

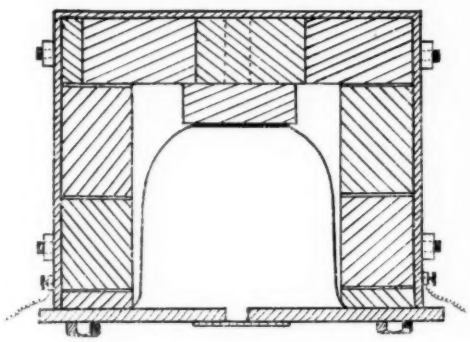

Fig. 13.—Lawton Electric Furnace.

twelve months, and the nichrome pot will last 10,000 hours' continual use. A 90-lb. heat of aluminium is stated to be capable of being melted for about 1½d. in this furnace, whilst it probably costs at a minimum 6d. per 90 lb. heat in either the gas or solid fuel furnaces. It is cleaner in working than any other furnace; after the current is switched on it requires no attention until the metal is ready to be withdrawn. The melting takes from ten to fifteen minutes when the furnace has reached about 650 deg. C. It is thought by the author that the electric furnace will be the principal melting medium for aluminium and white metals, etc., in the near future.

Book Reviews.

Practical Microscopical Metallography, by R. H. Greaves, D.Sc., and H. Wrighton, B.Met. Published by Messrs. Chapman & Hall, Limited, 11, Henrietta Street, London, W.C.2. Price 16s. net.

The authors of this book are both attached to the Woolwich Research Laboratories. The subject is covered by 13 chapters, which deal successively with the preparation of the specimens and a description of the metallurgical microscope through the structure of pure metals, alloys, ingot iron, wrought iron, various steels, heat treated, worked, hardened and tempered; alloy steels, pig-iron, cast iron and malleable cast iron, copper, aluminium and zinc alloys and bearing metals. It is beautifully illustrated by 156 microphotographs, supplemented by 28 line drawings. The book is definitely orthodox, which is to be commended in such a work, unless some indication is given in the title which leads one to anticipate departure. For instance, when speaking of the effect of sulphur in cast iron, the authors state that in any form it is objectionable, and should be kept as low as possible. This is not exactly true, but it is orthodox, and as the book covers a wide field it is sufficient for the purpose. It is clear that the authors are primarily expert on the metallurgy of steel and their conception of cast iron has been developed from this standpoint. We notice that their excellently reproduced microphotographs have bestowed upon the manganese sulphide a reasonable tint. Too often have we seen "dove-grey" manganese blacker than the graphite.

There is one phrase to which we take exception, that is, "polishing of cast irons presents no ununusual features." A definite technique in this direction has been developed, with which the authors should make themselves familiar, as its inclusion in such a book would render it of so much more value to the many laboratories concerned with material. However, the book is one which we can recommend to our readers.

Combustion in the Gas Producer and the Blast Furnace: A New Theory, by Dr. A. Korevaar. Published by Messrs. Crosby Lockwood & Son, Stationers' Hall Court, Ludgate Hill, London, E.C.4. Price 15s.

The author, who is lecturer in industrial chemistry at the University of Leiden, Holland, has developed a new theory for the reactions which take place in gas producers and blast furnaces, and, incidentally, although the author does not state so, in cupolas. The law enunciated has reference to heat compression, and apparently is based upon

$$A + B + C - D = a = F$$

where A equals a constant quantity of air per min. introduced into the combustion zone; B a constant quantity of heat developed by the burning of a constant quantity of carbon per min.; C the quantity of preheated carbon which replaces the carbon burnt every minute, and D the quantity of heat lost per min. Therefore a is the available heat and F the heat loss, which are equal in the stationary state of a gas producer. In the first part of the book, dealing with the gas producer, the author has developed a new theory of combustion which culminates in the formation of a law of heat compression. It shows by compressing (or should be localising?) the heat in a furnace a higher temperature with a constant fuel consumption should be produced or by compressing the heat a definite temperature with a lower fuel consumption. This compression is achieved by modifications of the factors governing volume or temperature of the zone of the combustion. The factors are the activity, porosity, size and ash content of the carbon; the velocity, temperature and moisture content of the air and the radius and conductibility of the furnace. The results point to economy from compressing the heat by means of better combustible fuel, low ash, hot blast and a larger furnace.

We do not pretend to have mastered the whole of the theory, but we have certainly been able sufficiently to appreciate the author's work, that we are convinced that it is worth while studying by the metallurgists engaged in blast-furnace plants or occupied with large cupola installations.

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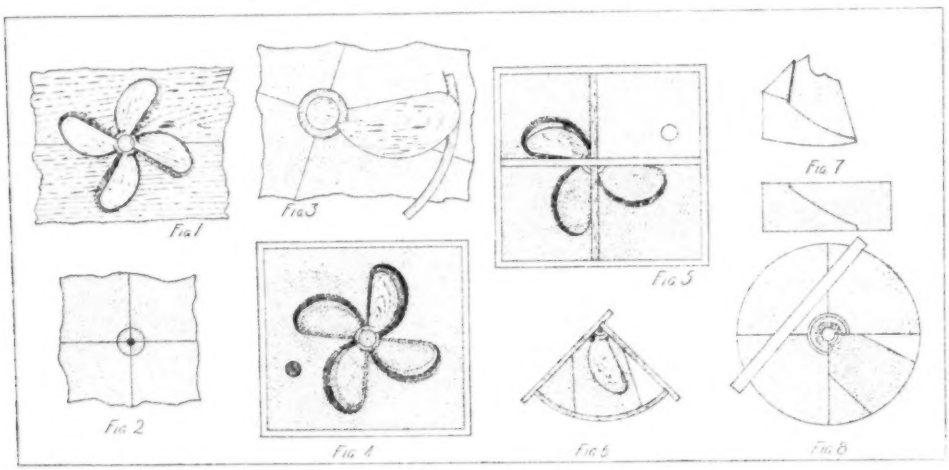
Making Propellers.—III.

By Ben Shaw and James Edgar.

Moulding Small Propellers.

When either full or sectional patterns are supplied for large propellers, the moulds may be made in loam or sand, usually the latter, but those for small propellers are invariably made in sand. A green-sand mould is generally used when the propeller required is to be about 2 ft. dia., whilst dry sand is usually preferred for those that exceed this diameter, and yet that come under the category of small propellers. When the mould is to be formed with cores the cores are invariably dried, and either core sand or wet loam may be used to form them. Some foundries, it must be understood, make practically all cores from loam mixtures, while others use sand mixtures whenever possible. Whether the moulds are green or dried it is advisable to face them, not only to give a smooth skin to the resulting castings, but to help the flow of the metal. The edges of the propeller blades are not cast as knife edges, but are thickened up according to their size; on small propellers they are generally fine, and the faced mould ensures a more accurate filling. The facing used will vary with the metal of which the casting is to be composed, it being dusted on a green sand mould, or, better still, applied with a camel-hair brush and the surface very carefully sleeked. A wet facing is applied when the mould is dried. This consists of a suitable facing mixed with water to a creamy consistency and having just sufficient bond added to it to cause the facing to adhere to the mould surface when the moisture has been evaporated from it. Too much bond will make the facing wash too strong, and cause the facing to crack and peel on drying the mould.



Using a Full Pattern.

The method of making the mould for a small propeller varies with the type of pattern supplied, and we purpose considering some of these variations when a mould is to be made from a pattern that is a replica of the casting, from a sectional pattern consisting of one blade and the boss, or from a core box containing one blade and part of the boss. Making a mould from a full pattern is undoubtedly the easiest and most profitable from the moulder's point of view, but, as we have stated in a previous article, unless the propeller is very small, considerable extra labour is involved in making a full pattern, and this has an important bearing on the cost of the finished casting. One of three methods is generally used in making a mould from a full pattern, a turnover board may be used, an oddside formed, or the pattern may be bedded into the sand and the joint made direct. The use of an oddside or turnover board is similar in principle, but the former method necessitates ramming up a box part for making a temporary joint, and because of this the turnover board is to be preferred. The pattern is laid upon the level board with the working surface uppermost and sand is tucked under each blade, as in Fig. 1, so that it can be sleeked off to form a suitable joint. When this has been done and parting powder used, it is a simple matter to ram up a drag part placed on the board over the pattern. It is not advisable to turn over the board and drag together if a wood pattern is used, although this should be done if the pattern is of metal. The drag may be lifted and the wood pattern, being very light, will be lifted with it, leaving the sand which has formed the joint on the board. Some tooling may be necessary to the joint before commencing the cope, but the completion of the mould is soon effected.

The pouring gate should be placed on the boss, and, since the smallest bit of dirt or dross entering with the metal will invariably cause a blemish on the outside, much care must be exercised to prevent other than clean metal entering the mould. A filter-core placed in the neck of the runner is an excellent means of attaining this end, particularly if a slip of paper is placed over it. This holds the metal until the pouring cup is about full.

When the pattern is bedded in the drag is rammed up and sleeked off level with the joint surface; upon this the pattern is laid with the working surface down, and sand is tucked under each blade as before and a joint formed; afterwards the method is similar to that employed when a turnover or joint board is used.

Using a Sectional Pattern.

The making of a mould from a sectional pattern is not nearly so easy as the foregoing. With this form of pattern the moulder is relied upon to locate the blades with accuracy, both with regard to their relative positions and pitch, and the surface of the end of the boss is a very indifferent means for obtaining even a close approximation to accuracy. Frequently only the sectional pattern is supplied, from which the moulder attempts to produce an accurate casting without any jig arrangements to assist him. The result can be well imagined, for it is impossible to maintain the correct pitch without some form of guide. We recommend the use of a small circular wood disc smaller in diameter to the boss, and fitted with a dowel upon which the blade and boss can ride and an angle plate upon which the blade can rest, maintaining its correct position during the time sand is rammed under it to give the requisite support.

The angle plate can be cut from tinplate and bent to follow the sweep of a diameter less than the required propeller. Wood segments can be fixed to the bottom to enable the plate to stand vertically. A vertical centre line should be marked on the plate to locate its position when it is being set. The pitch of this angle plate must, of course, correspond with the pitch of the required propeller at the diameter at which they coincide

when in use. The provision of these supplementary parts materially assists the making of an accurate mould and incidentally simplifies the job. To make the mould a level bed is first prepared, either in a box part or on the foundry floor, and the small circular disc is bedded in about the centre. The surface of the disc should be flush with the bed, and centre lines should be drawn on the bed to suit the number of blades required. Fig. 2 illustrates the method when four blades are required. From the centre dowel describe a circle on the sand bed corresponding with the diameter at which the angle plate is to be set. The angle plate can then be located and the pattern, riding on the dowel, rotated until in contact with the angle. It is as well to mark points on the angle when the contour of the blade intersects. A weight should be placed judiciously on the pattern to maintain its position while the drag is being formed.

The sand forming the bed directly under the blade should be broken and additional sand carefully rammed to form the pitch surface. When sufficient sand has been rammed to act as a bearance, the angle plate can be removed and further sand applied to complete the shape. It is advisable, as far as is possible, to allow the sand to project beyond the blade contour and following the pitch, as this forms a bearance and gives a better definition of the blade. The projecting sand ought to be given as much taper as possible to the level bed in order to facilitate the stripping of the cope.

When one blade surface has been prepared the pattern is rotated, anti-clockwise in this instance, and the angle plate set for the same operation to be repeated. The process is continued until the complete drag is formed as in Fig. 4, when the cope can be rammed. Making the cover presents some difficulty when the pattern carries one blade only and one of two methods is generally adopted. Either a number of sectional pieces of tinplate are cut to correspond with sectional shapes of the blade and used as guides to form a sand thickness or the cover for each blade is rammed up separately. The former method is adopted when the mould is dried and when the small propeller exceeds 2 ft. in diameter. The wood pattern forms one blade; the remaining blades, being formed in sand, are temporary, and directly the cover impression has been made these temporary blades are removed and the pattern stripped. Preparing the cover for each blade separately is usually preferred when the mould is made in green sand and as the pattern must be moved to suit the number of blades required, wood bars should be fixed in the cope box to form partitions as in Fig. 5. The bars should be chamfered off near to the joint. When the cover for one blade has been made the box part is lifted and the pattern stripped and set for the next blade. Each blade must be covered in this way before the cope is completed, when it is lifted for the final stripping of the pattern. The circular disc in the drag is the last to be removed, and its impression requires to be filled in. The intersection of the box bars prevent central running from the top, but it can easily be run at the bottom of the boss by means of a horn gate.

Using a Core Box.

We have already referred to the use of a core box as a profitable method for making small propellers, and two types of suitable core boxes were illustrated in the previous article; that shown in Fig. 6 is generally preferred because the cores can be made direct on a metal plate for drying. We referred to the fact that, in some pattern shops, a wood or plaster bearance is made upon which the working surface of the blade rests, and which form a joint surface to facilitate the making of the part cores; they are, however, few. It is generally left to the core-maker to prepare the bearance in the form of a core. The use of a wood or plaster bearance is undoubtedly better, because the pattern is liable to spring, it having such small contact with the core-box sides. Obviously, therefore, when the core-maker prepares his own bearance he must exercise considerable care to avoid springing the pattern. It is not always essential to use grids in these cores but small grids or irons, to which wires are attached, facilitate lifting and are convenient in assembling the cores when dried. The first part of one core is illustrated in Fig. 7. It will be noticed that the joint follows the pitch surface, and it is set off to the box level as in Fig. 8. The sharp corner of sand is cut off, and a recess is made to reduce this weakness in the second part also. When one part has been prepared the second part can be made over it. Some core-makers prefer to dry this first core in order to use it as a bearance for all the cover cores. This is quite an excellent practice, as the additional time involved is small and insignificant in comparison with the greater convenience of making subsequent cores. The cover core may, of course, be made on a green bearance core, and many core-makers consider this method quite satisfactory, though more care is involved. The most important advantage obtained from the use of a dried bearance core is the greater stripping facilities it affords, as, when one cover-core has been made a core plate may be placed over the core box and both turned over, the core box loosened and stripped, when the dried core can easily be removed and the pattern withdrawn. This process can be repeated until the four cover cores have been made, the core box being assembled each time and the bearance core set in it. The first cover core should be placed in the oven to be dried while the remaining cover cores are being made, so that it can be used as a bearance for the remaining three bottom cores. By adopting this method it is not necessary to handle the cores while they are green, the newly-made core resting flat on a core plate when the core box is stripped from it, after which it can be transferred to the oven. When the eight cores have been dried and a facing wash applied, it is not a difficult matter to assemble them to form a complete mould. A level sand bearance should be prepared upon which they can be laid. They should be weighted and a pouring cup located preparatory to casting. Sand should, of course, be rammed about the outside of these cores although the side pressure when casting is small.

A block pattern, from which an impression could be formed to receive these cores, would be an advantage, but, when only one or two castings are required, the advantage is not commensurate with the cost of the pattern.

Gases Evolved During Carburisation.

Mr. Victor E. Hillman, Director of Research, Crompton & Knowles Loom Works, of Worcester, Mass., U.S.A., writing in the "Iron Age," summarises his conclusions as follows:—

(1.) Slow or accelerated heating does not alter the analysis of the gas evolved at the several temperatures adopted; (2) for a given temperature there is a definite maximum concentration of carbon monoxide; (3) at higher temperatures the activity of the cements investigated is due essentially to CO; (4) the evolution of carburising gases practically ceases at 840 deg. C. This value is nearly consistent with the complete dissociation temperature of calcium carbonate; (5) the maximum percentage of carbon monoxide is found within the range 760 to 815 deg. C. The upper value is nearly consistent with the best temperature for cementation. The mechanical properties of the steel, *i.e.*, brittleness of "core" or "heart," are less affected at 840 deg. C. than at any other carburising temperature; (6) prolonging the time at 840 deg. C. does not give rise to appreciable volumes of gas. Herein lies the advantage of luting carburising boxes. Boxes sealed with fireclay prevent the escape of the active gases which are in the carburising box at 840 deg. C. If the carburising gases were not entrapped, heating above 840 deg. C. and prolonging the time would be futile toward appreciably increasing the depth of cementation; (7) all of the compounds investigated gave rise to a saturated hydrocarbon, namely, methane. Sufficient methane is evolved at 590 deg. C. to effect some degree of carburisation. Charpy maintains that he obtained true cementation as low at 565 deg. C with this gas; (8) the illuminants or unsaturated hydrocarbons were at all times less than 1 per cent.

XUM

Notes on Venting, Ramming and Runners.

By Ecossais.

The advice, "ram hard and vent well," is often given in a foundry, but unqualified acceptance of such advice is apt to cause much trouble. Venting is only an artificial aid to assist the sand and allow gases and air to escape away from the face of the mould instead of entering the mould itself. It is possible to ram some varieties of sand so hard, and without great effort, that no amount of venting will effect this result. The sand face may be so closely packed as to admit of no expansion, when heated by contact with the metal, except into the mould space, producing the defects known as shell scabs or buckles. These leave unsightly hollows in the face of a casting when removed. The blowing which generally also occurs at such places may cause portions of such sand to become entirely free and float on the metal to the upper parts of the casting, forming sand holes and leaving behind a patch of solid scab to be chipped off.

The closer the sand the more prevalent this trouble. An experienced moulder realises this, and also knows the difference between "hardness" and "firmness," using the vent wire to provide channels for the collection of the gases escaping through the pores of the sand in those areas not pierced by the wire. Hand ramming makes the sand grains lie closer together, and thus reduces the permeability of the sand, so that the vent channels need to be closer together to assist easy escape of the gases. With coarser sand the spaces between the grains are greater, and fewer channels will be necessary than with the closer or finer sand, even though both are rammed equally hard. To ram hard unnecessarily, and thus render extra venting necessary, is to use energy needlessly. It is frequently found that small wooden patterns are so disfigured by vent wire marks as to make impossible the production of presentable castings from them. This is due to lack of knowledge on the moulder's part of the possibilities of his sand if properly treated. With small castings, and many others where the depth is not great, ramming with a peg rammer (which often gets too near the pattern) may be dispensed with, except round the sides, and in the final stages in some cases, the sand being either pressed with the hand, shovel handle or trodden, being finished off with a flat rammer on plenty of sand.

By this means a mould can be made practically self-venting, for after scraping off the excess sand the mould is uniformly firm and open, without the irregular character and dead pockets produced by the small-ended peg rammer. Many of the defects found in castings only when machining commences may be put down to defective ramming. Although the mould may have been well vented and the gases appear to have escaped freely, blowing may have occurred during casting, without any outward indication at runner or risers, due to their position, and the resultant casting may be thought perfect until machined.

A common error in the case of the sides of deep moulds, especially when the casting is a heavy one and takes relatively a long time to pour, is the provision of continuous vents close to the mould face. These allow large quantities of steam to pass, which, being cooled and condensed by the relatively cold upper end of the vents, saturates the adjacent face of the mould long before the metal reaches it, resulting in boiling and scabbing, when eventually the mould is filled. The better way is to have two, three, or more series of vents at different levels, where they are collected by channels filled with dry coke leading away to the outside of the pit to vent pegs common to all levels, thus leading the gases and steam away from the mould face at casting time.

A good illustration of what happens can be had from consideration of a large wall-box, with internal webs top and bottom. If vents are made vertically and continuous from one web to the other, the face of the upper web is practically certain to blow and scab. The slower such a mould is filled the greater the probability of such steaming, which, with the best of conditions, is always present and accounts partially for the increasing tendency to dry or skin-dry moulds of large size. The rate of pouring may be increased or reduced by respectively hot or dull metal, and often accounts for the apparent anomaly of less scabbing with hot metal than with dull metal, the dull metal allowing greater opportunity for the effects of the steam and being also less able to recover from contact with damp portions of the mould.

In the case of dry-sand moulds removed to a stove for complete drying, as distinct from skin drying, much laborious venting may be dispensed with, except in the case of complicated moulds.

If the whole of the mould is rammed up in a strong, close sand, or stoving conditions are bad, extra venting may become necessary, to allow for quicker drying by providing outlets for steam. Unless boxes have to stand severe handling the practice of coating the outside of a mould with claywash may be discontinued with advantage, as providing a serious obstacle to the escape of gases and creating greater need for vents. Although it is often stated that extra vents are never lost, the effect on some patterns is deplorable, and, independent of the extra labour and time for venting, extra finishing is also entailed. Except in cases where a mould is completely rammed up in a pit after drying, there are very few cases of dry-sand moulds where venting could not be practically eliminated, provided that after a facing of core sand next the pattern the remainder of the mould consisted of ordinary floor sand rather damper than as used for green-sand work, such sand drying quite firm and allowing gases to escape freely. In the case of moulds buried entirely in the floor, after drying the necessary vents should be collected by means of a layer of coke inside the moulding box, and led to an outlet above the floor, or if vents come to the outside of mould, use may be made of hay, laid up the side of the box while ramming up the pit.

Runners do not always get the attention they deserve, and as the whole of the metal has to pass through these before entering the mould, this neglect is surprising. A dirty runner or ingate means a dirty casting, and later a number of excuses for the dirt, reference being made to "dirt" in the metal, "poor ganister," which has become mixed with the metal, and others just as ridiculous, though given quite seriously. It is, of course, impossible for dirt (generally sand) or ganister to be actually mixed with the metal, though it may be carried along with or suspended in the metal, as slag, especially if the metal is dull, in which case it is not suitable for important castings. Hot metal, good skimming and the use of stops will prevent ladle dirt from entering the casting with reasonable care in pouring. The relative sizes of ingates and down runners and the position of ingates require careful consideration. If the total area of the ingates is very much less than that of the down runners the metal will enter the mould at high speed, and possibly tear some portion of the mould face away, even though the position of the ingates has been carefully considered. Standard sizes of down runners and runner cores, also patterns of gates (as examples of such definite areas) will help the moulder, and reduce the amount of what is too often considered as unnecessary calculation.

Catalogues Received.

Cast-Iron Pipes. The Monthly Stock List of cast-iron pipes for October issued by the Staveley Coal & Iron Company, Limited, of Chesterfield, is now available.

Horizontal and Vertical Steam Engines. We have received from Marshall, Sons & Company, Limited, Gainsborough, two four-page leaflets descriptive of these two types of engines.

The name of N. G. Fergusson & Company, Limited, 13, St. Helens Place, London, E.C.3, has been changed by special resolution and consent of the Board of Trade, and will in future be Fergusson, Wild & Company, Limited. Major John McK. Campbell and Mr. J. P. O. Dutton have joined the board.

Effect of Sulphur on Blast-Furnace Process in American Practice.

In a Paper on this subject, to be presented by Mr. T. L. Joseph (metallurgist, U.S. Bureau of Mines) at the Birmingham (Alabama) meeting of the American Institute of Mining and Metallurgical Engineers this month, and printed in the "Transactions" of the Institute, he shows from data covering the operation of 35 American blast furnaces that for each ton of pig-iron made, an average of 1.38 lbs. of sulphur is charged with the ore, 19.9 lbs. with the coke, and 0.33 lb. with

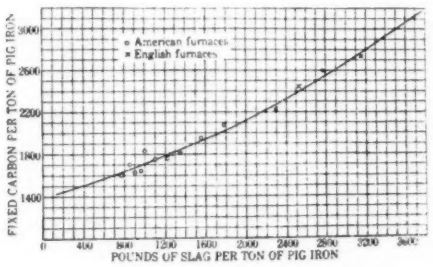


Fig. 1.

the limestone, or a total of 21.61 lbs. Thus approximately 92 per cent. of the total sulphur charged enters with the coke, 7 per cent. with the ore, and 1 per cent. with the limestone. Most of the sulphur is disposed of by means of the slag, which carries off an average of 86.7 per cent. of the sulphur charged, 4.63 per cent. being incorporated into the metal. In a number of cases the sulphur in the slag and metal exceeded the total sulphur charged. These discrepancies the author assigns to difficulty in obtaining representative samples and partly to errors in chemical analyses. However, the conclusions concerning the value of coke as its sulphur content varies are based on relations existing between three operating quantities, namely, sulphur in the coke, slag volume, and coke consumption. An item, sulphur unaccounted for (averaging 1.99 lbs., or 8.64 per cent. of the total charged), contains the accumulated errors of calculations involving the weights of all raw materials per ton of metal and the analysis of raw materials and products. It is important to observe that only 4.61 per cent. of the sulphur charged may be allowed to enter the metal, and this makes the elimination of sulphur difficult because the allowable percentage is so small. The quantity of sulphur to be eliminated affects not only the amount of slag that must be carried, but also its composition. This, in turn, determines its free-running or critical temperature. The average slag volume of the 35 furnaces was 1,107 lbs.

The author remarks that he has recently given a relationship which shows* that 0.46 lb. of carbon is required to melt 1 lb. of slag; this is equivalent to 0.52 lb. of coke containing 86 per cent. fixed carbon. Aside from the cost of limestone, the elimination of sulphur is directly responsible for 150 lbs. of extra coke. On a basis of 2,000 lbs. of coke per ton, this is a 7.5 per cent. increase in fuel consumption, and causes a 7.5 per cent. loss of tonnage.

In the manufacture of pig-iron in the States, 41,976,171 tons of coke were consumed in 1921. The sulphur in the coke cost the resources of the country approximately 3,000,000 tons of fuel during that year; this illustrates the importance of the sulphur problem in present blast-furnace practice; in the future, it will assume greater importance because the use of fuel higher in sulphur content will be necessary. These principles have a direct bearing on the proper valuation of metallurgical coke. They also emphasise the importance of supplying the blast-furnace superintendent with low-sulphur coke if he is expected to operate on a low fuel consumption.

The sulphur balance in the data collected by the author indicates that most of the sulphur must be removed by the slag. The quantity of sulphur discharged from the furnace, of course, is equal to the product of the slag volume and the percentage of sulphur it contains. The sulphur content of the slag, however, is not a constant. It will depend on the temperature, volume, basicity, alumina, and manganese content of the slag. The temperature, in its turn, depends on a number of operating factors, particularly on the burden and the composition of the slag. A basic slag promotes desulphurisation, because it attains a higher temperature and because it is chemically more active as a sulphur solvent.

The weight of slag made in producing one ton of pig-iron can, in general, be taken as a measure of the sulphur present in the raw materials. If a large quantity of sulphur is to be eliminated, a large slag volume must be carried or the sulphur content of the slag must be high. In adjusting slag volumes, furnace operators bear in mind the maximum quantity of sulphur with which they may have to contend. Operators using high-sulphur coke must guard against higher peak conditions. In individual cases, the maximum sulphur in the coke might be considerably in excess of the average sulphur. In such a case, the slag volume would appear out of proportion with the sulphur in the coke. Operating data from 36 furnaces indicate that a rather definite relation exists between slag volume and the percentage of sulphur in the coke. To determine this relation, two factors (slag volume and sulphur in the coke) have been isolated. Thirty-six furnaces were arranged in order of increasing sulphur in the coke, divided into four groups, and the slag volume and per cent. sulphur for the representative groups were averaged. These averages are given in Table I. In basing conclusions on relations worked out under actual operating conditions, various factors covering individual practices are taken into account.

Table I.

	Sulphur in coke.	Slag volume.	Coke consumption.
	Per cent.	Lbs.	Lbs.
Group 1	0.72	946	1,950
,, 2	0.81	986	1,843
,, 3	1.07	1,133	2,030
,, 4	1.36	1,385	2,230

It is necessary to carry additional slag when using high-sulphur coke, as the following calculations show. A furnace using 1 per cent. sulphur corresponds to a slag volume of 1,100 lbs. This quantity of slag would require a fuel consumption of approximately 2,000 lbs. This fuel will contain 20 lbs. of sulphur. The ore, according to the data previously given, will introduce 1.38 lbs. of sulphur, making a total of 21.38 lbs. charged into the furnace. The sulphur in the limestone is so small that it can be neglected. If the sulphur in the pig-iron is 0.03 per cent., 0.67 lb. will be incorporated into the metal. A 10 per cent. loss by volatilisation will leave 18.57 lbs. of sulphur, which must enter 1,100 lbs. of slag, producing 1.69 per cent. sulphur in the slag. The sulphur in the average slag is 1.67 per cent.; the maximum sulphur in the slags from which this average was taken was 2.30 per cent. The author mentions that he does not wish to give the impression that desulphurisation could not be accomplished with a smaller slag volume; for purposes of calculation the average values are more nearly representative.

Table I shows that as the sulphur in the coke increases, it is necessary to carry additional slag volume. From a study of operating data, the author has recently developed a relation between slag volume and coke consumption; this relationship is shown in Fig. 1 for English and American furnaces.

* "How Silica Affects the Cost of Pig-Iron."

The principal plants of the British Empire Steel Corporation showed an increase in production for the first seven months of 1924, as compared with the corresponding period last year. The production of pig-iron for the period amounted to 159,457 tons, as against 140,567 tons, while the output of ingots totalled 171,803 tons, as compared with 160,925 tons for the first seven months of 1923. For the whole year 1923 production amounted to 277,681 tons of pig-iron and 297,988 tons of ingots.

Institute of British Foundrymen.

NEWCASTLE BRANCH.

The annual general meeting was held on September 27, the chair being occupied at the opening of the proceedings by Mr. James Smith.

Annual Report of President and Council for Session 1923-24.

Seven meetings were held during the session, including the annual general meeting. At five of these Papers were read, and one meeting took the form of a general discussion. The average attendance was between 80 and 90.

The total membership of the Branch is now 230, a decrease of 31 since the previous report. This large decrease is chiefly due to the number of members who have fallen into arrears with their subscriptions. The detailed membership is as follows:—Subscribing firms, 10; Members, 70; Associate Members, 85; Associates, 65.

The Junior Section has had five meetings for the reading and discussion of Papers. In addition to these, a successful smoking concert was held, and visits were paid to several important works.

The annual Convention of the Institute was held in Newcastle on June 4, 5 and 6, about 330 members and ladies attending from all parts of the country. The foundrymen's associations of America, France and Holland were also represented.

Mr. R. O. Patterson, a Past Branch-President, was elected President of the Institute for the Session 1924-25. The new rules for Branches are now in operation, and to conform with them it will be necessary for the annual meeting to be held not later than April 30 of each year instead of in September, as in this and previous years.

The General Council has awarded diplomas to O. Smalley, for his Paper on "Volume Changes of Cast Iron on Solidification"; J. D. Nicholson, for his Paper on "Green Sand Moulding"; and C. Gresty, for his Paper on "The Examination and Photography of Cast Iron under the Microscope."

Mr. H. A. J. Rang, who has been Hon. Secretary of the Branch since its formation in 1912, resigned the position on June 7. The President and Council desire to put on record their appreciation of the long and valuable services he has rendered to the Branch.

At a special meeting of the Branch Council on June 16 Mr. Colin Gresty was elected to act as Hon. Secretary until the annual meeting in September.

It is with great regret that the death is recorded of Mr. R. Wallis, who was President of the Branch from 1912 to 1914, the first two years of its existence.

Election of Officers.

The Chairman reminded the members that they had a very important duty to perform in the nature of electing officers for the ensuing year. Mr. Frier had been Vice-President of the Branch for the past two years, and they very much appreciated his services, more particularly perhaps as a member of the Branch Council. It afforded him the greatest pleasure, therefore, to propose that Mr. Frier be Branch-President for the following twelve months.

MR. H. J. YOUNG said he had much pleasure in seconding this proposal. He had worked with Mr. Frier many years, and considered him to be one of the finest foundrymen on Tyneside and that they could not have a better President.

Mr. Frier was unanimously elected.

In vacating the chair in favour of the new President, MR. SMITH said he hoped that Mr. Frier would have a very happy year of office.

MR. FRIER, in accepting the Presidency, said he did not propose saying anything at the moment beyond thanking everyone for electing him.

MR. EDWARD SMITH said he had much pleasure in proposing that their Junior Vice-President should become Senior Vice-President. He was sure that Mr. Herbst, who was an old member of the Branch and who had the Institute at heart, would prove a very able Senior Vice-President. As a result of the ballot Mr. E. Wood was elected Junior Vice-President, having a majority of twenty votes.

MR. WOOD nominated Mr. H. F. Parsons as Treasurer, and said he had had the pleasure of working with Mr. Parsons during the Convention, and was sure they would find that his qualifications would prove equal to the hard work to be dealt with, namely, the gathering in of the accounts of the Branch.

MR. YOUNG seconded the proposal, and Mr. Parsons briefly expressed his thanks.

As Secretary, MR. R. O. PATTERSON nominated Mr. Colin Gresty. He said that during the Convention they had all seen Mr. Gresty's organising ability, and, therefore, he was sure they could not make a wiser choice for a Branch-Secretary. Mr. Stobie seconded the motion, which was unanimously carried.

In reply, MR. GRESTY expressed his thanks to the members for the honour they had done him. He had no illusions now that secretarial work was easy, and could only say that he would do his best.

The following were then re-elected to the Council:—Messrs. S. Dickinson, G. Lillie, H. F. Parsons, and R. H. Smith, in addition to Messrs. Victor Stobie and C. W. H. Holmes.

The three representatives to the General Council chosen were Messrs. J. N. Simm, James Smith and H. J. Young.

Presentation of Diplomas.

MR. FRIER said he had pleasure in asking the President of the Institute (Mr. R. O. Patterson) to present the diplomas won by the members of their Branch.

MR. PATTERSON said it gave him much pleasure to present diplomas to members of the Newcastle Branch. He thought that their Branch had done exceedingly well during the last session, and was sure that those awards had been well-earned.

He expressed his regret at not being able to present one to Mr. Smalley, owing to the latter's absence from the country. In making the presentation to Mr. Nicholson for his Paper on "Green Sand Moulding," he said that, to his mind, green sand moulding had always been a more skilful section of the trade than dry sand moulding. He hoped that they would have some more interesting papers on the same subject.

The next diploma which he had to present was to their Secretary, Mr. Colin Gresty, for his Paper on "The Examination and Photography of Cast Iron under the Microscope." Microscopic work was something about which he could not say very much, but the little he had done had shown him that it certainly was a valuable aid to foundrymen to be able to study their products under the microscope. The question of pearlitic iron was coming to the fore very much nowadays, and one could only, he supposed, get that particular structure by means of the microscope, but how to get it was a different matter. He had seen some sections of metal under the microscope, made by some very well-known foundries, and which showed that they were entirely on the wrong track. The graphite plates were more like dinner plates—(laughter)—and he believed that it was only by the aid of the microscope and its specialists that we could hope to arrive at a better quality in our products.

A vote of thanks was then accorded to Mr. Patterson for presenting the diplomas.

PRESIDENTIAL ADDRESS.

MR. FRIER then delivered his presidential address, in the course of which he said:—

GENTLEMEN,—

It was my hope, when elected to the vice-chair, that if it came to my turn to be your President I should be able to congratulate the members on a spell of good trade. I am sorry, however, to say that pleasure is not for me, but I sincerely hope that, before my term of office expires, brighter days will be with us.

Yours is a very ancient and honourable craft—ancient it must be, since we claim to have taken part in the building of the great Temple of King Solomon, and more honourable to-day than ever in the position we hold in the engineering world, due, in a very large measure, to the work of the Institute of which we are proud to be members.

As a working member of that craft I feel how

little more we know compared with the craftsmen of those ancient days. No doubt there are many people to-day connected with the engineering industry, when they see the large and intricate castings, fail to appreciate the work of the present-day foundryman. Take the largest turbine which is being shipped to America from Tyneside, namely, the latest achievement of the Hon. C. A. Parsons. I cannot express my feelings as I stood on that massive piece of work, and I felt proud that I was a member of a craft that turned out such splendid work.

Very few people who saw that engine had any idea of the important part the foundryman played in it or had any knowledge of the hard, laborious work, the anxiety, thought and care necessary in producing large or small castings. Most foundrymen who have crossed the Newcastle high level bridge have felt proud of the part the foundryman had in its construction, and no doubt wondered how it was done. They had not the assistance of the metallurgist in those days, and those responsible for the work must have spent hours of anxiety and thought.

The Work of the Institute.

How little foundrymen knew of the inner working of their craft when the scientist came in and upset all their preconceived notions. When the metallurgists thought it worth their while to join the Institute they must have had both respect and admiration for the men who were struggling in the dark. We do not always agree with them, but we must admit they have enlightened us and taught us, even against our will, to a deeper and more scientific appreciation of our trade. I recall my first chat with a chemist, which opened with: "I cannot do your work, you cannot do mine, but together may we not achieve something?"

This is the spirit with which chemists are welcomed into modern foundries, especially when they fully appreciate the work the foundryman has done. To-day, more than ever, with the strides made by the Diesel engine, the foundryman does need the help of the chemist and the healthy co-operation of the foundryman and the engineer. On every side we hear of the difficulty in getting castings that will stand up to the stress of the vital parts of the oil engine, and of these castings having to be obtained from the Continent; why should this be? It is not that the foreign workman is superior, but because they make more use of the chemist and science in foundrywork.

The work of the Institute is to bring the foundryman, engineer and chemist together to discuss and solve the problems and troubles met with every day in the foundry. It is not only the heads of department, but the men who carry out the work who should benefit most from the Institute. If the majority of responsible foundrymen were members of the Institute there would be no trouble in getting the best type of boy into the foundry.

The Newcastle Junior Section.

At least two other Branches are starting, or have started, Junior Sections. We must look to our laurels. Our Junior Section was the first, but we must keep it alive. Employers must be told about it, and it should become a recognised educational centre for the foundry apprentices of Tyneside. We should hold examinations every year. Possibly as time passes every Junior Section will hold the same examination simultaneously, and the awards and certificates will be in diplomas of efficiency recognised by all.

It is essential for the nation that boys and young men shall take a pride and an interest in their trade, and shall strive to progress. Wherever we go we see our work as foundrymen, the steamship, the locomotive, the motor-car, in the street, and in our homes. Then have we not a right to feel proud, and in that pride to work together to build up that splendid monument "The Institute of British Foundrymen."

Vote of Thanks.

Mr. Patterson, in moving a hearty vote of thanks to Mr. Frier for his address, said that there were several points which he thought ought to be considered. The President had spoken about the castings we have made, and are very proud of, which have recently gone across to America, and he referred to the hard and laborious work in connection with those castings. He (Mr. Patterson) was rather disappointed that Mr. Frier did not also refer to the artistic part of the work. He considered that the present-day turbine cylinder was a masterpiece, looking at it from the foundryman's point of view. They had cast one at their own works that morning which had a core, roughly speaking 4 ft. sq. by 3 ft. deep, the latter being cut into quarters and joined in the centre by a piece of metal not much bigger than one's fist. How those moulders could get that core to stand up against the weight of the metal without any trouble was really astounding. Unfortunately, he personally did not serve his apprenticeship as a moulder, but as a fitter. He realised that those moulders were not only hard-working men, but they were artists.

In conclusion, he thought they had listened to a short but very thoughtful address.

Mr. James Smith said it gave him much pleasure to second the vote of thanks. When he himself was elected to the chair last session the Senior Vice-President had said how pleased he was to see a moulder occupying the Presidential chair. He (Mr. Smith) was just as pleased to see a moulder holding the Presidency this session.

Regarding his Presidential Address, he thought it was typical of a moulder to give an address of that kind, short but to the point. He sincerely trusted that Mr. Frier would have a very happy year of office, and felt sure that he would have the support of every member of the Branch.

Mr. Frier thanked the members for their appreciation of his small effort, and explained that it was difficult for him to write an address such as he felt the members would expect from their President. However, he had simply written what he felt, which was that the foundryman had a right to be proud of his work, and that if every foundryman was to show that pride it would be much better for the trade and better for the foundryman himself.

Vote of Thanks to Retiring President.

Mr. Lillie proposed a hearty vote of thanks to Mr. Smith, and said he thought they had had a most successful session, and it had been contemporaneous with a very important event, namely, the Newcastle Convention, which had been second to none.

When asking the members to accord the vote of thanks, he would like to couple the names of their lady reporter and lanternist with that of their retiring President. Mr. Stobie seconded the motion.

In reply, Mr. Smith said that although he may have failed in many ways, he had always done his best to help the Branch.

He had been a member for nearly twenty years now, and had watched very carefully the progress of the Institute since it was formed. They had now a lot of scientific friends, and sometimes he was afraid they were going to turn into a scientific Institute. He did not wish to say anything against the scientific man, although at one time he had not believed in him; but he wished to point out that the scientific man and the practical man must work in co-operation if we are going to have better results.

One used to be able to get a practical moulder who made his own metals and turned out first-class work, but one must not forget that the raw materials of to-day are not the same as they were years ago. If the high level bridge had to be built now they would find difficulty in getting irons to stand the tests, owing to the inferiority of the raw materials of to-day.

In conclusion, he wished the Branch every success, saying that he would do whatever he could, little as it may be, to help to advance the Institute.

The meeting was then closed.

Manufacture of Steel Sheets in India.—A staff of 66 men recently arrived in India from England to occupy the higher positions at the works which Messrs. Tata are starting at Jamshedpur for manufacturing sheets. With the new works in operation it is hoped to meet the growing demand for corrugated iron, which is now entirely imported.

Trade Talk.

THE NORTH LINCS. IRON COMPANY, LIMITED, have damped down the only two furnaces they had in blast.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, have established a branch at 119, Victoria Street, Bristol, where stocks will be kept.

BINT & COMPANY, iron, steel and metal merchants, etc., have moved from 10, Arthur Street, London, E.C.4, to 5, Dowgate Hill, E.C.4.

THE DIRECTORS of Brooks & Doxey, Limited, have decided to make a call of 1s. per share on the ordinary £1 shares, making them 18s. 3d. paid.

JOHNSONS CONCRETE ENGINEERING COMPANY, Manchester, have removed their head office to 47, Victoria Street, London, S.W.1.

ALLEY & M'LELLAN, LIMITED, Polmadie, have booked orders for one twin-screw tug, one stern-wheel steamer, and two barges.

G. BEATON & SON, LIMITED, manufacturing engineers, etc., have removed to the Beatonson Works, Victoria Road, Willesden, N.W.10.

MR. L. CHARBONNEL, iron and steel merchant, 56, Kingsway, W.C.2, has removed to Finsbury House, Blomfield Street, London, E.C.2.

MELVILLE & COMPANY, iron, steel and metal merchants and agents, have moved to 4, Lloyd's Avenue, London, E.C.3.

THE HODBARROW iron-ore mines at Millom were re-opened at the beginning of this week. About 400 men will be employed.

THE RIO TINTO COMPANY have now acquired the land at South Bank, Middlesbrough, for the erection of their new works.

LIVINGSTONE & COOPER, LIMITED, of Hessle, have received an order to build an oil tanker 450 feet long for the Union Steam Shipping Company of New Zealand.

C. A. HILL & COMPANY (Hilex Iron Company) have removed to Rilton House, 58-60, King Edward Street, Hull.

WILH. LUTTGE & COMPANY, iron, tinplate and metal merchants, have removed to 4, Lloyds Avenue, London, E.C.3.

NEARLY 80 MINERS, engaged chiefly in the Pecton seam of Dorman, Long & Company's Skelton Park Mine, have received notice to cease their employment. Many of the men will be found work elsewhere.

WATTS, HARDY & COMPANY (1920), LIMITED, have removed from Tyne Street, North Shields, to Clarendon House, Clayton Street West, Newcastle-on-Tyne.

THE COOPER STEWART ENGINEERING COMPANY, LIMITED, removed on October 6 from 11, Broad Street, Bloomsbury, to 136-137, Long Acre, London, W.C.

THE TWO BLAST FURNACES of the Seaton Carew Iron Company which are working at present produced last week 1,493 tons of hematite and 1,407 tons of basic respectively.

THE ANGLO-AMERICAN OIL COMPANY, LIMITED, propose extending their depôt at Sunderland Road, Gateshead, by the erection of additional storage tanks and an oil refinery.

COX & DANKS, LIMITED, who have the contract for raising the 26 German ships in Scapa Flow, have now raised their fifth vessel. It was the G 38, a torpedo boat destroyer.

JAMES GORDON & COMPANY, LIMITED, of Windsor House, Kingsway, London, W.C., have recently opened a branch office at 110, Waterloo Street, Glasgow, under the management of Mr. A. D. Burgess.

SWAN, HUNTER & WIGHAM-RICHARDSON, LIMITED, of Wallsend, have secured an order for four vessels for Belgian owners, the vessels to be of about 2,000 tons each. The engines will be built by the Wallsend Slipway and Engineering Company, Limited.

AN EXCURSION—probably the largest of the kind from Huddersfield and district—took place to London and the British Empire Exhibition at Wembley on Monday of last week, when about 1,300 of the employés of J. Hopkinson & Company, Limited, Britannia Works, had a day's outing on the invitation of the firm.

A CONTRACT HAS BEEN placed by the Air Ministry with Nortons (Tividale), Limited, of Tipton, Staffordshire, for the supply and erection of six large aeroplane sheds at Gosport, Rainham, North Weald and Martlesham. The buildings will have steel and asbestos roofing, and the approximate area of roof in each shed will be 34,000 square feet.

ALFRED INGRAM & COMPANY, railway contractors, of 1, Central Buildings, Westminster, S.W.1, advise us that as their office lease has expired and they require additional accommodation, they have taken offices at 17, Victoria Street, S.W.1. Mr. A. Douglas Ingram, who for the last twelve months has been with the Geo. Cohen and Armstrong Disposal Corporation in their railway and rolling stock department, is rejoining the firm of Alfred Ingram & Company.

THE LONDON office staff of Vickers and International Combustion Engineering, Limited, had the first annual dinner at the Connaught Rooms last week, Mr. George C. Usher, the general manager, in the chair, supported by Mr. G. R. T. Taylor (of Taylor Brothers, Limited), who is managing director.

THE TRENT IRON COMPANY, LIMITED, have posted notices stating that, owing to the serious depression and the accumulation of stocks, the engagement of all the men employed in their ironstone mines and blast furnaces terminated on October 3. Thereafter any work will be on a day-to-day basis.

MR. J. C. BISHOP and Mr. O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, have been informed that the average net selling price of Scottish manufactured iron for July and August brought out is £12 10s. 11.18d. This means that there will be no increase in the wages of the workmen.

THE MAKERS of the Huttenes coke-fired air-blown mould and core stove furnaces, described by Mr. T. W. Barley in his Paper before the Refractory Materials section of the Ceramic Society, is the International Processes, Limited, of Basildon House, 7, Moorgate, London, E.C.2. The representative for the northern counties is Mr. F. J. Shaw, of 20, Carterknowle Road, Sheffield.

TWO STEAMERS with iron ore for the Seaton Carew Iron Company, Limited, have lately been discharged at the docks at the rate of 1,034 tons and 1,274 tons per day respectively. The two blast furnaces of this company which are working produced last week 1,493 tons of hematite pig-iron and 1,407 tons of basic pig-iron respectively, being 50 per cent. more per furnace than the pre-war production. These figures are local records.

CHRISTMAS & WALTERS, LIMITED, of Caxton House, Westminster, have received a large order on behalf of the High Commissioner for India, for Blaw patent metal forms for concrete shuttering. The firm is so placed that large consignments will be quickly made. The Blawforms will be used not only for property building, bungalows, etc., but also for sewers and other structures. This is one of the largest orders probably ever placed for metal shuttering for concrete.

THE VICKERS AND INTERNATIONAL COMBUSTION ENGINEERING, LIMITED, have just closed another contract for the power plant of a large flax mill in Belfast, owned by the York Street Flax Spinning Company, Limited. The contract is for the complete design and erection of all buildings, coal-handling plant, boilers and furnaces, burners, etc. The boilers are of B. & W. type, each having 9,270 sq. ft. heating surface, and the pulverising plant is the "Lopulco," the pulverisers being of Raymond five-roller type.

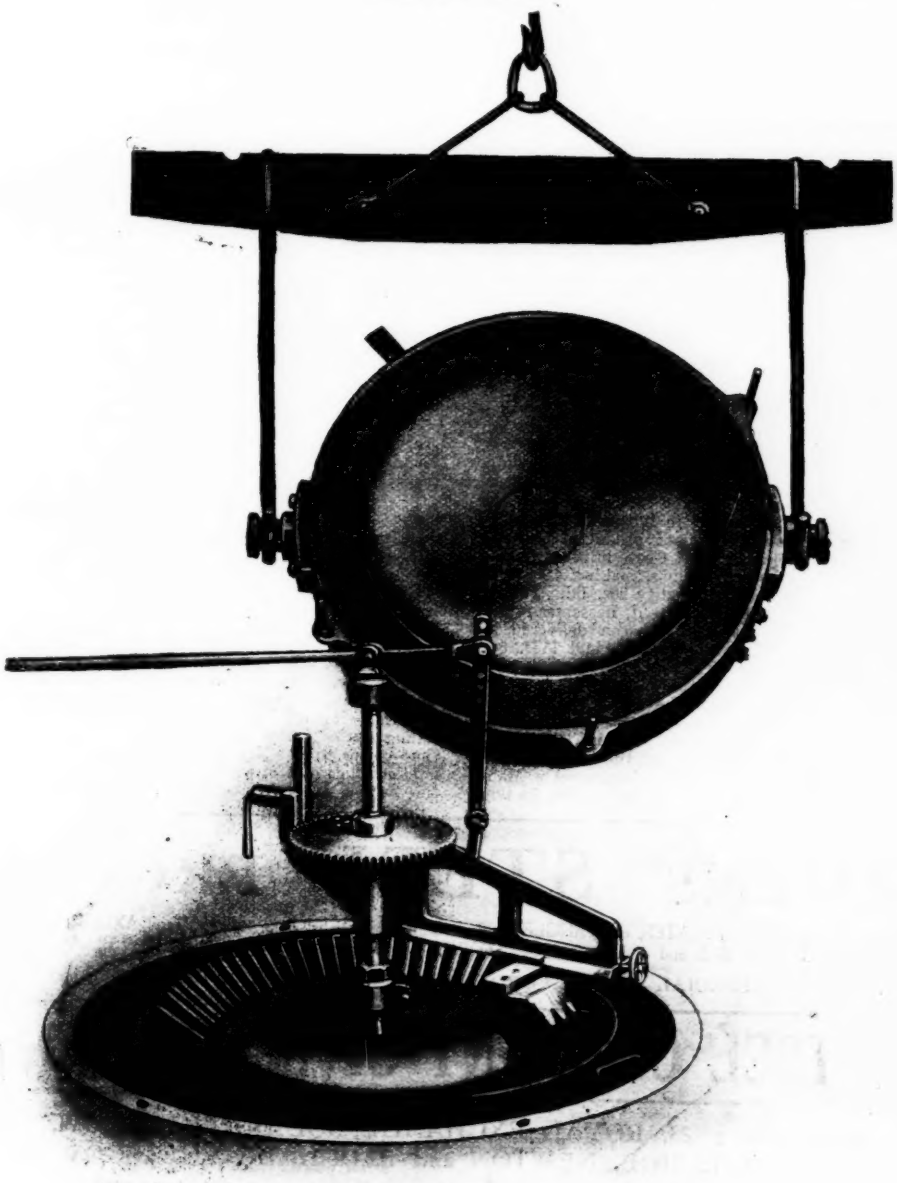
SUTCLIFFE BROS. & BRYCE, LIMITED, Globe Works, Hyde, have acquired and incorporated in their company the old-established boiler-covering business of W. J. Hockey & Company, of Cardiff. Mr. W. J. Hockey has joined the board of Sutcliffe Bros. & Bryce, Limited, and will manage this branch of the business as heretofore. The acquisition of these works and offices will afford Messrs. Sutcliffe greater facilities for carrying out their Welsh contracts than they have hitherto enjoyed. The address of the new branch will be: Sutcliffe Bros. & Bryce, Limited, W. J. Hockey & Company Branch, Hodges Row, Docks, Cardiff.

THE COUNCIL of the Institution of Civil Engineers have made the following awards in respect of selected engineering papers published without discussion during the session 1923-1924:—A. Telford Gold Medal to Mr. E. H. Lamb (London); and Telford Premiums to Messrs. F. C. Temple (Jamshedpur, India), H. A. Lewis-Dale (London), and C. J. Gyde (Pretoria). In respect of papers read at students' meetings, the James Forrest Medal, the James Prescott Joule Medal and a Miller Prize have been awarded to Mr. R. W. Mountain (London); and Miller Prizes to Messrs. H. S. Smith and C. D. Crosthwaite (London), H. C. Toy (Birmingham); F. W. S. Hawtayne (London); E. G. Wilson (North Shields), and W. W. Davies (London).

THE DIRECTORS of the London Iron and Steel Exchange have decided to begin this year's autumn session of the Exchange by instituting a service of telegrams from Glasgow, Middlesbrough and Charleroi, giving the conditions and prices ruling in these markets. At the autumn quarterly meeting of the Exchange at the Metal Exchange Rooms, Whittington Avenue, E.C.3, on Tuesday, October 7, a short address will be given by Sir William Clare Lees, President of the Manchester Chamber of Commerce, and Chairman of the British Committee on Arbitration of the International Chamber of Commerce on "International Commercial Arbitration." The subject is one of considerable importance to the iron and steel trades of this country, as legislation is under consideration by the British Government and by the Governments of many foreign countries to amend existing laws in order to facilitate arbitration in commercial disputes between their various nationals.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,
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BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron trade continue extremely unsatisfactory, both as regards home and export demand, nor can it be said that there are any encouraging signs of an improvement, at all events as far as early autumn requirements are concerned. Last week there was rather more inquiry from Scotland, but trade in that direction is necessarily handicapped by the sales of Belgian foundry iron to Scotch consumers at a lower c.i.f. price than that obtainable from Middlesbrough. In the export section business is somewhat improved in volume, the shipments of pig-iron from Middlesbrough (including Skinningrove) during September amounting to 31,989 tons, as compared with 29,965 tons in August, an increase of 2,024 tons. The shipments to Scotland, however, dropped from 18,501 tons to 10,020 tons, and this is probably in some measure due to the fact that imported iron has found its way into Scottish foundries. With buyers holding off all the time for still lower prices, and with sellers anxious to pick up business even at cut figures, quotations become all but meaningless. Basing on 80s. for No. 3, No. 1 will be 85s. per ton, No. 4 foundry 79s., and No. 4 forge about 78s. per ton.

The slight improvement in the inquiry for hematite recently recorded has not been maintained. Indeed, the home demand has fallen off still further, while the inquiry from abroad is at a very low ebb. Meantime stocks are accumulating, and unless these can be liquidated by an improvement in business, it is difficult to see how a curtailment of production can be avoided. The quotation for East Coast mixed numbers is down again by another shilling, making the price 88s. per ton, with the No. 1 quality 88s. 6d. In the North-West area prices are unchanged, Bessemer mixed numbers being quoted at 102s. per ton delivered at Glasgow, 108s. 6d. per ton at Sheffield, and 113s. 6d. per ton at Birmingham.

LANCASHIRE.—Most of the foundries in this district consuming on a restricted scale, the demand for No. 3 quality iron is considerably below the usual season average, and prices are irregular. Buying, however, will largely depend upon the effect of the recent lowering of coke prices, but in any case Manchester buyers of foundry iron will not expect to pay more than 90s. per ton delivered, and it is almost certain that if the furnace agents will not at once come down to this figure some of the more speculative merchants will do so. It may perhaps be doubted whether much difference will occur in Scotch or in hematite iron. The former has been "beared" for some time. Down to 104s. delivered has been heard of for Scotch No. 3, although the official prices are from 107s. to 108s.

THE MIDLANDS.—Notwithstanding the recent sharp decline in coke values in this district, the subsequent fall in foundry pig prices has not had the stimulating effect upon business that was so confidently anticipated, and founders continue buying only for immediate needs. Close fracture foundry iron is being sold at 84s., delivered in this district, which is about 75s. to 76s. f.o.t. furnaces. Ruling quotations for pig-iron are as follow:—Derbyshire No. 3 foundry, 82s. 6d. to 85s.; Staffordshire No. 3 foundry, 85s.; Northants. No. 3 foundry, 79s. to 80s.

SCOTLAND.—A slight improvement in inquiry is reported in the Scotch markets for foundry pig, and consumers in one or two quarters seem to be considering the question of buying a little farther ahead than has been their custom for some considerable time. Whether this is the forerunner of the usual autumnal buying or not remains to be seen, but prior to this the indications have been that the buying which is usually expected to take place at this season of the year was not going to materialise. Quotations are, however, again easier, and the price of No. 3 foundry may be called nominally 90s. per ton at the furnaces.

Scrap.

Reports from the various centres of the scrap metal trade are practically unanimous in describing the conditions as abnormally stagnant, buyers being few and far between, while prices continue the weakening process. At the moment Lancashire dealers are asking 85s. for really good broken machinery cast scrap, but in buying this class of material it will be well to reckon that the selling price may not be over 80s. when the time comes to put the scrap on the market. In Scotland supplies of cast scrap seem to be fairly good, but the trouble is in finding buyers and suitable outlets.

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